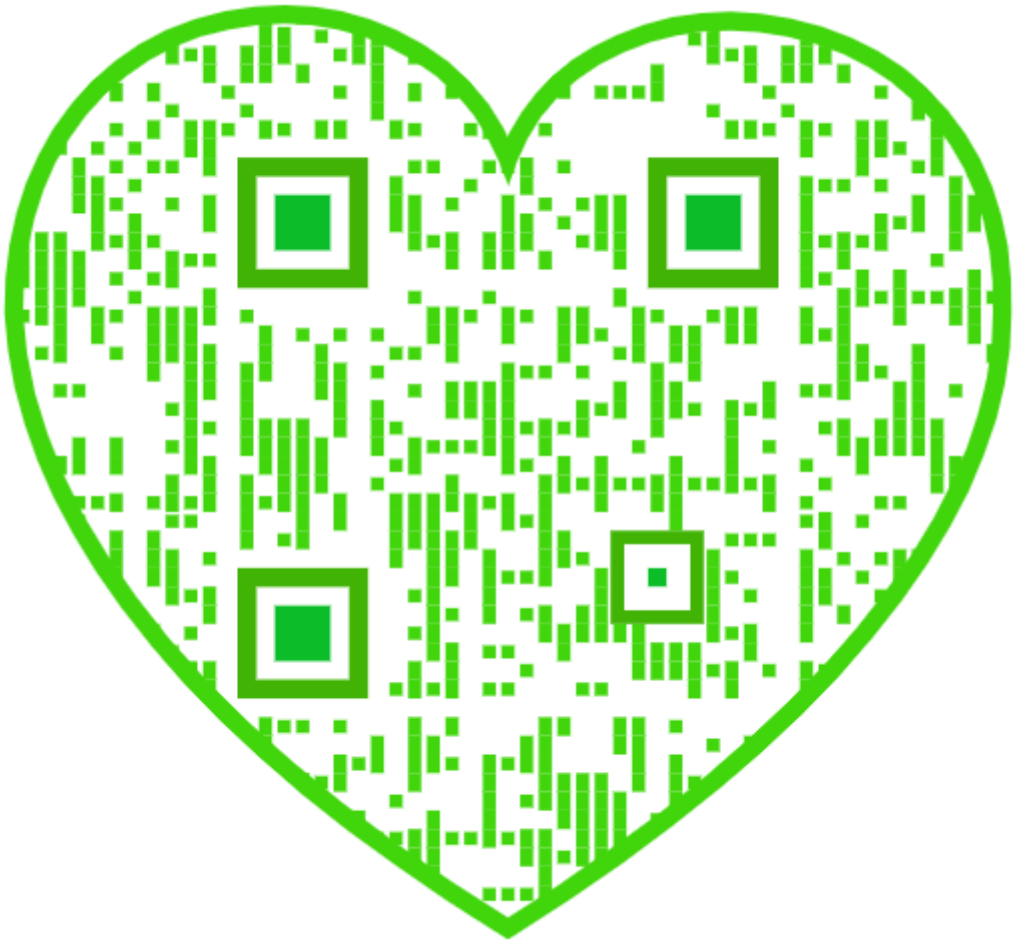

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PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF AGRICULTURE

(SOIL AND CROP DIVISION)

THE POTATO IN BRITISH COLUMBIA

BULLETIN No. 86

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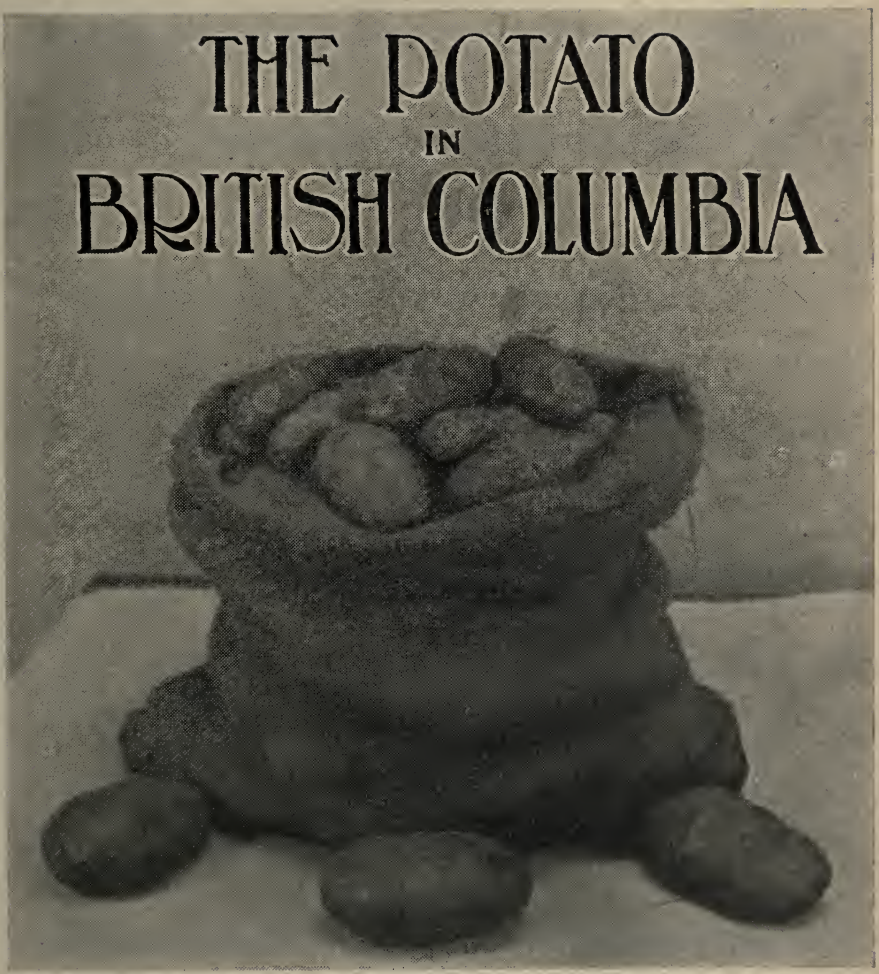
THE POTATO IN BRITISH COLUMBIA



DEPARTMENT OF AGRICULTURE,

VICTORIA, B.C., January 31st, 1921.

To His Honour WALTER CAMERON NICHOL,

Lieutenant-Governor of the Province of British Columbia.

MAY IT PLEASE YOUR HONOUR:

I have the honour to submit herewith for your consideration Bulletin No. 86, entitled "The Potato in British Columbia," which has been prepared by Cecil Tice, Soil and Crop Instructor, under the direction of Dr. D. Warnock, Deputy Minister of Agriculture.

I have the honour to be,

Sir,

Your obedient servant,

E. D. BARROW,

Minister of Agriculture.

DEPARTMENT OF AGRICULTURE,

VICTORIA, B.C., January 31st, 1921.

Hon. E. D. Barrow, M.L.A.,

Minister of Agriculture, Victoria, B.C.

SIR,—I have the honour to submit herewith for your approval Bulletin No. 86, entitled "The Potato in British Columbia," which has been prepared by Cecil Tice, Soil and Crop Instructor, of the Live Stock Branch of this Department.

I have the honour to be,

Sir,

Your obedient servant,

DAVID WARNOCK, O.B.E.,

Deputy Minister of Agriculture.

PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE
(LIVE STOCK BRANCH).

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Veterinary Inspector.

WM. J. BONAVIA,
Departmental Secretary.

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ERRATA.

Page 20, 11th line—"The sprouts should be allowed to grow so long that they will be broken off in planting" should read "The sprouts should not be allowed to grow so long that they will be broken off in planting."

Page 42, 1st line—"Grower B 3 tons to the acre" should read "Grower B 4 tons to the acre."

THE POTATO IN BRITISH COLUMBIA.

By Cecil Tice, B.S.A., Soil and Crop Instructor.

INTRODUCTION.

THE potato is one of the most widely cultivated of all agricultural plants and few crops are of more general interest. As human food potatoes rank second only to wheat. The potato-crop is one of the chief sources of food the year round, and also a very valuable cash crop to the settler or the man with small capital. Almost every farmer in this Province plants potatoes, and a very large number of the citizens of our towns and villages grow potatoes in their gardens. Any improvement in the crop is therefore of interest to both large and small growers, and it is with this object in mind that this bulletin is published.

Fig. 1. An exhibit of British Columbia potatoes (original).

In the Province of British Columbia the climate is ideal for potato-growing, the Colorado potato-beetle is so far unknown, and some of the more serious potato-diseases, such as leaf-roll and mosaic, are very little in evidence. For this reason it behoves the growers not only to take advantage of those conditions with which nature has been so good as to endow us, but to couple with them better cultural methods, improved selection of seed, and a more complete control of such diseases as late blight, *Rhizoctonia*, and *Fusarium* wilt.

HISTORY.

The potato is a native of the mountainous districts of Chile and Peru, where it is still to be found growing wild. It has been proved beyond doubt that at the time of the discovery of America the cultivation of potatoes was practised with every appearance of ancient usage in the temperate regions of South America, extending from Chile to New Granada, at altitudes varying with the latitudes. This appears from the testimony of all the early travellers.

The potato was introduced, probably in the latter half of the sixteenth century, into that part of the United States now known as Virgina and North Carolina. It was imported into Europe between 1580 and 1585, first by the Spaniards and afterwards by the English, at the time of Sir Walter Raleigh's voyages to Virginia.

It is believed that the potato was first introduced into Ireland in 1586 by colonists sent out by Sir Walter Raleigh, and was at first cultivated on Sir Walter's estate near Cork. The cultivation of potatoes then extended from this place to the poorer Irish classes and later into England. The cultivation of the potato in England made little progress and potatoes were scarce for many years.

In 1769 the grain-crops of France were a failure, threatening a national famine. Parmentier, a chemist, recommended the use of potatoes to supplement the grain-crops. These were tested out and found to be so palatable that they soon became a staple food of the French people.

In 1772 the potato was used to supplement the grain-crop of Germany also.

In 1663 the Royal Society of London recommended the introduction of the potato into Ireland, as a safeguard against famine. By 1840 it had become the staple food of the Irish people. In 1845 the so-called late-blight disease was beginning to attract widespread attention, and it caused great loss in this year, both in North America and Western Europe. In 1846 it destroyed the potato-crop in Ireland, giving rise to a famine.

In America the settlers were using the potato for food in the seventeenth century. The production has gradually increased and improvement been made by the origination of new varieties and improved cultural methods, so much so that to-day it is one of the most important cultivated crops.

BOTANICAL CHARACTERS.

The potato belongs to the Solanaceæ, a family containing about 1,500 species, distributed in about seventy genera. It includes a number of economic plants besides the potato; e.g., egg-plant, tomato, tobacco, etc. (The sweet potato, however, belongs to a different family.) The genus *Solanum* contains about 900 species, chiefly from tropical America. *S. tuberosum*, the potato, is one of the best known.

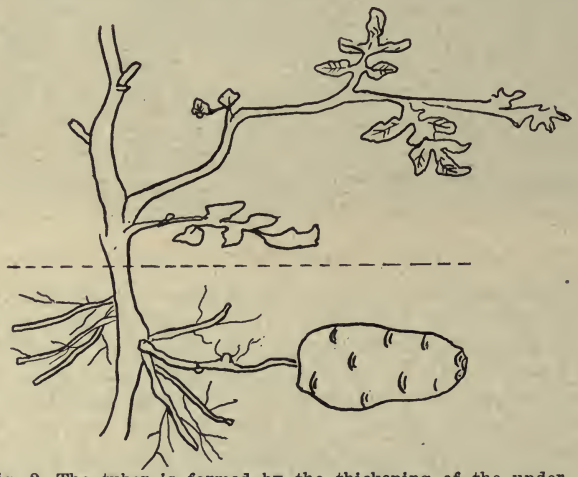

Fig. 2. The tuber is formed by the thickening of the underground stem (after Montgomery).

The potato is a herbaceous plant; annual as regards its aerial shoots, but perennial by means of its tubers. The leaves are alternate on the stem, compound pinnate, with a terminal leaflet. Leaflets petiolate. Small leaflets occur in between the normal ones. The leaves vary a good deal in different varieties.

The stems are of two kinds: (1) Aerial or leaf-bearing, but erroneously spoken of as "vines"; (2) underground or tuber-bearing (rhizomes). These two forms are

fundamentally the same, and the underground form can be changed into a typical leafy shoot if brought above ground. The rhizomes, or stolons, are not to be confused with the real roots, which are slender fibres ramifying through the soil to a depth of 2 to 4 feet. The stolons are short, 1 to 4 inches long, and the tuber is formed by the thickening of the free end (Fig. 2). The "tubers," then, are simply terminal portions of the underground stems swollen with reserve food in the form of starch.

At the "stem-end" the remains of the stolon can usually be found, while at intervals over the surface the "eyes" occur, each eye being a bud, or more correctly a cluster of buds. The tuber consists of the following parts (Fig. 3) :—

(1.) *Periderm*, or skin, which comprises the corky covering of the tuber. On the skin, as on the woody bark of trees and other plants, are "lenticels" (Fig. 4), or pores, closely filled with cells and serving as a channel for the admission of air to the internal tissues. Ordinarily they are hardly noticeable, but in the case of tubers grown on wet soil they increase in size, and when the tubers are freshly dug are white and glistening. Such tubers are often mistakenly considered to be diseased.

Fig. 3. Cross-section of a potato (original).

(2.) *Cortex*, or layer just inside the skin. This is very rich in starch.

(3.) *Vascular ring.* This contains the vascular bundles, which include the sap-vessel. It is this ring that turns brown at the stem-end of the tuber when the wilt-fungus is present.

(4.) *Medulla*, or pith. This includes everything inside the vascular ring and comprises the greater portion of the tuber. It consists of an outer dense layer and an inner lighter, more or less star-shaped area, poorer in starch.

The "eyes" are arranged in a spiral around the tuber, close together at the end remote from the "stem-end." This is termed the "seed-end," "eye-end," or "rose-end." Each eye is formed in the axil of a small scale-leaf, which disappears as the tuber matures. The strongest eyes are found at the "seed-end." The number

and distribution of the eyes vary much, not only in different varieties, but also within the same variety.

The flowers vary in colour from white through pinkish and purplish shades to blue. The colour of the flower is of importance in recognizing varieties. In some varieties the flowers never open.

The fruit is a round berry known as a "potato-apple," "potato-ball," or "seed-ball." It is two-celled and when normally developed is usually many-seeded. Seeds are only used for propagation when new varieties are to be developed. Tubers produced by seedlings are usually small the first year, normal size being reached about the third year. It is commonly thought that the long propagation of the

Fig. 4. Enlargement of "lenticels" on potato (original).

potato by tubers has resulted in a degeneration in seed production, and it has even been stated that in certain varieties tuber production is inversely proportional to the floral development, "the best tubers and largest yield being produced by the type of plant whose flower-buds do not even swell."

POTATO PRODUCTION.

The following figures taken from the Year Book of the United States Department of Agriculture give the yield in millions of tons of some of the most important food-plants of the world. Owing to the war, figures for years 1915–19 are very incomplete and have therefore been omitted.

This table is the average for the five years 1911–15:—

Table I.

	Million Tons.
Potatoes	161.33
Corn	116.50
Wheat	115.10
Oats	73.20
Rye	52.16
Barley	42.00

The average annual production of potatoes was 161.33 million tons or over 5,000,000,000 bushels. The production of corn, wheat, and oats centred around 4,000,000,000 bushels. Potatoes therefore lead all other crops in total production. The wheat-crop, however, has the greatest money value in the world, with potatoes and corn probably ranking second and third respectively.

Table II. is an approximate estimate of the percentage production of the world's crop of potatoes as contributed by the various continents. The figures given have

been obtained from the average production for the years 1911–15. However, in some of those years figures were incomplete, and so estimates for previous years have been substituted.

Table II.

Continent.	Per Cent. of World's Crop.
Europe	87.7
North America	9.6
Asia	1.3
South America	0.9
Australasia	0.4
Africa	0.1

Nearly 90 per cent. of the world's potato-crop is grown in Europe and only about 11 per cent. on the American Continent. The probable reasons for this large difference are because, in Europe, labour is more plentiful and cheaper, and also potato-growing is carried on more extensively among the poorer classes.

Fig. 5. Typical Netted Gems (original).

In the same period, 1911–15, the average production in millions of bushels is given in Table III. for the chief potato-producing countries, together with their average yield per acre for the years 1900–15, inclusive.

Table III.

Country.	Millions of Bushels. Average 1911–15.	Av. Yield per Acre in Bushels, 1900–15.	Bushels *per Capita.*
Germany	1,750	202.8	25.4
European Russia (including Poland)	1,169	103.9	8.7
Austria-Hungary	580	134.3	11.7
France	449	125.5	11.3
United States	362	94.5	3.9
Great Britain	140	208.5	3.4
Ireland	127		29.1

From Table III. it will be noted that Germany and European Russia together produce over 2,900,000,000 bushels, or over 50 per cent. of the world's potato-crop. The greatest average yield per acre is obtained by Great Britain and Ireland and the lowest by the United States.

The number of bushels *per capita* varies greatly in the different countries. Great Britain and Ireland together only produce 6.1 bushels *per capita*, but Ireland alone produces over 29 bushels *per capita*, which is a higher quantity *per capita* than any other country. Potatoes are therefore, without a doubt, a most important crop as far as the agriculture of that country is concerned.

POTATO PRODUCTION IN CANADA.

In studying potato production in the Dominion of Canada the following information is obtainable for the five-year period 1915–19:—

Table IV.

Acreage.	Annual Production in Bushels.	Av. Yield per Acre in Bushels.	Value of the Crop.	Bushels *per Capita.*
633,934	86,692,620	135	$77,875,000	12

The production of potatoes in Canada is approximately 20 per cent. of the production of the North American Continent and about 1.3 per cent. of the world's crop; a production which equals that of Asia.

The average yield per acre is 10 bushels lower than the average yield of the more important potato-producing countries, and the number of bushels *per capita* is about 1 bushel lower than the average for the same countries.

The distribution of the potato-crop in the various Provinces of the Dominion is given below:—

Table V.

Province.	Acreage.	Yield per Acre.	Production in Bushels.	Number of Bushels *per Capita.*
Quebec	207,275	144.75	29,311,200	14.6
Ontario	150,697	114.75	15,195,400	6.0
Saskatchewan	55,108	148.25	7,675,380	15.5
New Brunswick	51.569	176.25	8,003,760	22.7
Nova Scotia	44,502	183.00	7,727,000	15.8
Alberta	39,308	151.50	5,515,320	14.7
Manitoba	36,653	150.00	4,905,900	10.7
Prince Edward Island	32,955	171.75	5,192,060	55.3
British Columbia	15,867	*204.25	†3,166,600	8.0

* 6.1 tons. † 94,998 tons.

That British Columbia is not a heavy producer of potatoes will be readily seen from studying Table V. The acreage of potatoes in British Columbia is approximately 2.5 per cent. of the acreage for the Dominion, and the production 3.6 per cent. In yield per acre, however, British Columbia stands above all other Provinces; therefore the production of potatoes in this Province is relatively higher in comparison with acreage than it is in any other Province, a factor which is worthy of interest. Furthermore, the average yield per acre compares very favourably with that of Great Britain and Ireland.

It will be noted also that higher average yields per acre are obtained by all the Maritime Provinces than are obtained by the inland Provinces.

That the potato is a very important crop in Prince Edward Island is very noticeable, the number of bushels *per capita* being greater there than in any other Province and almost double that of any country.

Table VI. shows the acreage, average yield per acre, total yield, and total value of the potato-crop in British Columbia for the ten years 1910–19, inclusive. In order to obtain more definite information as to whether or not the potato industry is progressing here, comparison is made of the five-year period 1910–14 and 1915–19, inclusive.

Table VI.

Year.	Area in Acres.	Yield per Acre in Bushels.	Total Yield in Bushels.	Total Value.
1910	10,872	150.03	1,631,211	$1,748,000
1911	14,974	252.31	3,778,000	2,493,000
1912	17,000	233.15	3,995,000	1,958,000
1913	15,000	207.30	3,110,000	2,053,000
1914	14,700	182.00	2,675,000	2,087,000
Average	14,509	*204.95	†3,037,840	2,067,800
1915	16,000	247.28	3,956,000	$1,780,000
1916	15,300	189.00	2,892,000	2,024,000
1917	15,024	166.55	2,502,000	1,726,400
1918	15,013	228.00	3,423,000	3,320,300
1919	18,000	170.00	3,060,000	3,060,000
Average	15,867	‡200.16	§3,166,600	2,382,140

* 6.1 tons. † 91,285.2 tons. ‡ 6 tons. § 94,998 tons.

During the past five years the acreage has increased by over 1,000 acres. Unfortunately, however, the average yield per acre has decreased, and thus the total production and total value of the crop is not proportionately as large as it should have been. This would lead one to think that yield was being sacrificed for acreage, rather than acreage for yield. The aim of every grower should be to increase the average yield per acre.

Table VII. will show the acreage, relative value, and annual market value of the potato-crop in British Columbia in comparison with other crops:—

Table VII.

	Average Acreage, 1915–20.	Relative Value, 1915–19 (Average).	Average Annual Market Value per Acre, 1915–19.
Hay and clover	140,536	6,416,600	34.33
Oats	53,753	2,240,520	39.28
Spring wheat	21,817	944,620	45.31
Potatoes	16,139	2,382,140	144.74
Alfalfa	12,160	891,640	64.84
Fall wheat and mangels	8,218	361,800	47.21
Turnips (4 years)	6,529	1,218,380	225.35
Barley	4,462	262,840	35.04
Rye	†3,517	*140.500	†62.80
Mixed grains	3,200	108,760	33.53
Beans	‡2,748	*161,500	‡78.00
Peas	1,703	95,440	54.03
Fodder corn (4 years)	1,283	218,100	84.07

* 1918 and 1919. † 1916, 1917, and 1918. ‡ 1919.

It will be observed from this data that, although the potato acreage in British Columbia is smaller than that of any other Province in the Dominion, nevertheless it ranks fourth in acreage in comparison with other crops within the Province; second in relative value and in average annual market value per acre.

The importance of the potato-crop in comparison with other crops, therefore, cannot be overestimated in this Province.

CHIEF POTATO-GROWING SECTIONS OF BRITISH COLUMBIA.

Much of the land in the Province of British Columbia is adapted for growing large yields of good-quality potatoes. The general quality and character of our product has been recognized for a long time. Some of the chief potato-growing sections are the Delta and bottom lands of the Lower Mainland, the Ashcroft

District, and several other districts in the Thompson River Valley. Around Armstrong the production of early potatoes on the uplands has been made a specialized industry, while the river lands produce very large late crops. Other districts producing potatoes of good quality are Vernon, Kelowna, Grand Forks District, Lillooet, and Columbia Valley.

In the Saanich Peninsula on Vancouver Island there is much land capable of producing large yields of good potatoes, and although the output is not very large at the present time, the probabilities are that the industry will increase. Such districts as Comox, Metchosin, Errington, and Sooke may in time become important potato-producing centres.

Fig. 6. A potato-field in the Ashcroft District (original).

USES OF THE POTATO.

The potato may be used in several ways:—

(1.) *As Human Food.*—The potato is a staple article of diet in almost every household and it is considered a wholesome and nutritious food. The assumption that potatoes are not a healthful, wholesome food because they contain a large percentage of starch is not usually considered to be true.

The chemical composition of a raw unpeeled potato is: Water, 78.3 per cent.; protein, 2.2 per cent.; carbohydrates, 17.6 per cent.; fat, 0.1 per cent.; ash, 1.1 per cent.

From this is will be noticed that potatoes are very high in carbohydrates (starches, sugars, etc.) and low in protein (nitrogenous matter); therefore if eaten alone would form an unbalanced ration. However, if eaten with meat and eggs, etc., which are nitrogenous foods, a balanced ration is obtained, which is very necessary to produce health and vigour.

(2.) *As a Source of Starch.*—The starch of the potato is used in large quantities to make sizing for paper and textiles.

(3.) *As a Source of Alcohol.*—This industry, although unknown here, is carried on to a large extent in Europe.

(4.) *Potato-flour.*—The production of potato-flour in some countries, but not in Canada.

(5.) *As Feed for Stock.*—Potatoes, more especially the culls, may be fed profitably to stock. (This, however, is discussed fully in another part of the bulletin.)

QUALITY IN POTATOES.

Varieties of potatoes differ greatly in their cooking qualities. In Canada a mealy potato, white and floury in colour, is more desirable than one coloured or soggy after boiling.

Mealiness is directly associated with a high starch content. The grains of potato-starch expand and coalesce when boiled in water, and if the cells are sufficiently full of these bodies the boiling will cause the cellular structure to be broken down, which results in mealiness.

In a potato of poor quality sufficient starch is not present in the cell, and therefore its walls are not broken down in cooking; hence we have a soggy potato.

The following factors are considered to influence the quality of potatoes:—

(1.) *Type of Soil.*—Potatoes grown on a peaty soil do not possess the cooking quality of those grown on a sandy loam, because the rapid growth which the tubers make in peaty soils is likely to bring about watery tubers.

(2.) *Degree of Maturity.*—Potatoes are of the best quality when they have been fully matured, because the starch has been more fully developed. From this the need for a long growing season will be appreciated.

Fig. 7. An extreme case of second growth (original). The use of such potatoes for seed should not be tolerated.

(3.) *Storage.*—Potatoes lower their starch content in storage because enzymes work on the starch.

(4.) *Soil-moisture.*—Since moisture is a factor which influences the quality, the necessity for planting deep in dry soils, also constant use of the cultivator, is evident.

(5.) *Disease.*—Growth is often checked by disease such as "blight"; this can be overcome by proper spraying.

(6.) *Secondary Tubers.*—(Fig. 7.) This is a common occurrence in irrigated districts, because irrigation-water is applied at the wrong time. Irrigation-water should never be applied after bloom-time. The secondary tubers are due to the fact that at some period during their growth they were dried out, becoming partially ripened. Irrigation-water is added and growth again commences. The new growth takes the form of lumps. These potatoes are undesirable, as there is great waste in peeling and the cooking quality is lowered.

Certain external and internal features of the potato are associated with quality. The following are the chief features:—

(1.) *The Skin.*—An uneven surface with deep eyes is undesirable. A netted skin indicates maturity; therefore good quality. A smooth skin indicates a degree of immaturity; hence poorer quality.

(2.) Tubers are of poor quality where cortical layer is thick and dense.

(3.) Uniformity of external medullary area indicates an even distribution of starch in the cells. Non-uniformity indicates watery areas, and therefore poorer quality.

(4.) A large and branching medullary layer is an indication of more water than starch. When it is small less water and more uniformity in the starch is indicated, and therefore better quality.

The following score-card may be used in judging potatoes for quality:—

	Points.
Flavour	40
Mealiness	40
Appearance (colour, etc.)	20
Total	100

CLIMATE.

Cool nights with moderately warm, clear days, provided there is sufficient moisture in the soil, make ideal potato-growing weather. Such conditions exist in British Columbia. Humid sections are not the best for potato-growing, as conditions are more favourable for the development of serious fungous diseases, such as late blight, etc. Where the air is dry these diseases are unknown. Climate is probably a greater factor in potato production than soils, as potatoes appear to grow well on any productive soil in a favourable climate. The low average yield per acre in the United States, compared with other countries, is most probably due to climatic conditions, because the summer heat is too great in many localities and water-supply too small. In the State of Maine the air is much cooler and the yields much higher.

Fig. 8. Field of Netted Gem potatoes (original).

In studying agricultural conditions in various countries it is very noticeable that countries which grow good crops of corn produce poor crops of potatoes; the reason being that corn requires hot weather and potatoes cool weather. The chief potato-producing sections of Europe have a cool climate. Coming nearer home, we find that the Province of Ontario produces only 114.75 bushels per acre on an average, but British Columbia 204.25 bushels.

SOILS.

Many soils are adaptable for potato-growing; however, some soils will produce better crops than others, and are therefore more profitable. The ideal potato-soil is a rich, deep, friable, warm, sandy loam, or loam underlaid by a more or less clayey subsoil, which is provided with good drainage, either artificial or natural, and well supplied with organic matter. Heavy soils, although sometimes producing good crops of potatoes, are usually undesirable, since they are neither mellow nor porous; or, in other words, they are too hard and heavy, lack ventilation and drainage.

Furthermore, in heavy soils it is more difficult to plant, cultivate, and dig the crop; the potatoes are rough, off-type, and of poorer quality; the potatoes are more susceptible to disease and the crop does not mature as quickly. New soils are excellent for potato-growing, because they are rich in organic matter and are also freer of disease. However, like other soils, good drainage must be provided.

ROTATION.

The practising of a rotation is one of the most important factors in the growing of any field crop, for two good reasons: (1) It helps to maintain the fertility of the soil; (2) reduces weeds, insect pests, and diseases. In this Province farmers do not realize the necessity of a systematic rotation of crops as much as they should. Considered from the standpoint of disease alone, it is seldom wise to grow potatoes on the same land two years in succession. In planning a rotation, as far as it is practicable each crop in the rotation should serve as a helpful preparation for the one that is to follow. A successful rotation anywhere includes a legume-crop, a grain-crop, and a cultivated or hoed crop. The crops should be so planned that a piece of clover land is always available for potatoes. A common rotation that has proved very successful is:—

First year: Grain, as a nurse-crop for alfalfa or clover.
Second year: Clover or alfalfa.
Third: Clover or alfalfa.
Fourth year: Potatoes.

Such a system of cropping keeps up the supply of organic matter and the clover or alfalfa increases the nitrogen-supply.

Fig. 9. Green Mountain potatoes (original).

MANURES AND FERTILIZERS.

Manure.—Manure is another important factor made use of in keeping up the fertility of a soil. Barnyard manure and clover are the cheapest fertilizers for potatoes. It is generally conceded that fresh manure, especially horse-manure, applied to the land just before planting, tends to induce potato-scab. For this reason it is preferable to manure the previous year for potatoes. However, should this not be possible or convenient, the land may be covered heavily with fresh manure during the winter previous to potato-planting, or a spring application of well-rotted barnyard manure may be given. Whether manure will cause any such trouble or not depends on whether there is any scab on the seed-potatoes or in the soil, or

whether the stock has been fed uncooked scabby potatoes. If scabby potatoes are cooked before feeding, the seed-potatoes dipped for scab, and no scabby potatoes have been grown on the land within six years, the use of manure should not cause any scab in the crop.

From 8 to 15 tons of manure may be applied per acre. Smaller amounts can be applied with good results. Manure is better handled with a spreader, so as to be more evenly distributed.

A crop of clover furnishes as much nitrogen as 10 tons of barnyard manure per acre; the greater part of the nitrogen being gathered by the clover from the air. Clover brings up phosphoric acid and potash from great depths and adds humus to the soil, which makes the soil hold moisture better. Barnyard manure adds nitrogen, phosphoric acid, and potash to the soil, increases the humus content, and the soil is therefore more retentive of moisture.

It has been estimated that a crop of 6 tons of potatoes removes from the soil approximately 40 lb. nitrogen, 20 lb. phosphoric acid, and 70 lb. potash. A ton of barnyard manure contains approximately 10 lb. of nitrogen, 5 lb. phosphoric acid, and 9 lb. of potash; although the chemical elements are not all available for the crop, nevertheless from this it should be possible to estimate the approximate amount of manure required for potato land.

Fertilizers.—Where farmyard manure is not available, applications of commercial fertilizers can be profitably given. Fertilizers should on no account be used to replace either barnyard manure or clover, but rather act as a supplement. There are many potato fertilizers on the market, several of which have given very satisfactory returns. Definite commercial fertilizer mixtures cannot be recommended, because the soils of British Columbia vary so greatly. In some places the best results are obtained from an application of potash, in others from phosphoric acid, in others nitrogen, and in others from an application of a complete fertilizer. A good fertilizer for potatoes has been made by mixing 250 lb. nitrate of soda, 350 lb. superphosphate, and 200 lb. sulphate of potash. However, experiments should be carried out on each soil to determine the most profitable fertilizer to use.

In applying fertilizers several methods may be followed. In some instances fertilizer attachments are available in connection with the planter; however, in the majority of cases in this Province hand-sowing has to be reverted to. In this case care must be taken not to allow the fertilizer to come in direct contact with the seed. It is preferable to scatter broadcast and harrow the fertilizer in after the seed has been planted and covered.

Lime.—Much of the soil in this Province requires lime, and therefore in many instances will give greatly increased yields when same is applied. However, with potatoes, lime makes favourable conditions for certain diseases of the tuber, such as common scab, and for this reason it is undesirable. In fact, very heavy yields of potatoes are often grown on soils too acid to grow clover.

PREPARATION OF THE SOIL.

Land may be fall or spring ploughed for potatoes. Where the soil is heavy or where early planting is desirable, fall ploughing may be advisable. However, better results are usually obtained from spring ploughing. Fall-ploughed land is usually packed too hard when the time comes to plant the main crop of potatoes. Occasionally some farmers find it necessary to resort to fall ploughing in order to lessen their spring's work. No hard-and-fast rule can be given for the preparation of the land; nevertheless, enough work must be put on the land to ensure having a good mellow seed-bed. The ploughing-under of barnyard manure will loosen the soil, furnish plant-food, and increases the water-holding capacity of the soil.

In some districts, if a grower has the time, it has been found more satisfactory, when potatoes follow alfalfa, to double-plough the land. This is best done by ploughing in the very early spring just deep enough to cut the roots of the alfalfa a short distance below the crown. The plough is then followed by the harrow, which drags

out most of the alfalfa-crowns. A second ploughing, about 8 inches, is done just before planting. The object of this is to secure a loose, mellow seed-bed. In the case of pasture land it will be better to use a disk harrow rather than the ordinary harrow after the plough. The land should be double-disked the first time, lapping half the width of the disk and following the furrows. This should be followed by at least one more disking, after which the field should be thoroughly harrowed.

In districts where there is an insufficient supply of moisture every possible means should be made use of to conserve what there is. The land should be harrowed as fast as it is ploughed.

The importance of thorough preparation of the seed-bed cannot be overemphasized. Much of the tillage often necessary after planting could be greatly reduced if the land was in proper shape to start with. A quick start and strong early growth mean much in potato-growing.

Deep ploughing is required for potatoes. If the soil will stand it, it should be ploughed to a depth of at least 6 or 7 inches. Where land has been ploughed shallower, the depth should be gradually increased.

Fig. 10. Potatoes sprouted in the light (original). Compare the sprouts with those in Fig. 11.

SEED.

Condition of Seed at Planting-time.—All possible care must be given potatoes from which seed is to be selected, from harvesting-time until planting-time comes around again, in order that full vitality of the seed may be conserved and that the tubers may be in first-class condition. The important factor in this regard is that of storage. (Storage, however, is dealt with in another part of this bulletin.)

If possible, potatoes should be kept from sprouting in the dark before they are planted; however, if it is desirable to obtain extra-early potatoes, then they may be sprouted, but in the light (Fig. 10). Potatoes which are allowed to sprout in the dark take from the tubers plant-food and moisture (Fig. 11); these sprouts are usually broken off when handling the potatoes. The new shoots which are made when the potato starts to grow in the field have less moisture and less plant-food to draw upon, and therefore do not make as vigorous growth, with the result that a low yield is obtained.

Fig. 11. Potatoes sprouted in the dark (original).

Potatoes should not be used for planting that show a brown-ring discoloration at the stem-end. (For further information regarding this stem-end rot *see* "*Fusarium* wilt" under diseases.) Better still, avoid using potaoes which show disease of any kind, that are off-type, or are of an inferior appearance.

Greening Seed.—After seed has been sorted out it is a good plan, if extra-early production is required, to sprout the seed in the light. A few weeks before planting-time the potatoes are put in shallow boxes with seed-end up. The potatoes are then put in a bright, airy, cool place, where the temperature is low enough to prevent sprouting. After a few days the potatoes will turn green; then the temperature is increased. In a few days the warmth will start the buds and in the light the sprouts will grow short and stubby. The sprouts should be allowed to grow so long that they will be broken off in planting. If the seed is to be treated it should be done before it is spread out to green.

Where potatoes are sprouted in the light, only the strongest terminal buds start, and the seed is usually planted whole.

Selection of Seed.—A more careful selection of seed-potatoes could be profitably practised by the average grower. Insufficient attention is given to purity, freedom from disease, varietal characteristics, etc. Selection may be made while the crop is growing or after it has been dug and in the cellar. However, if best results are to be obtained, it is better to combine both field and cellar selection, for this reason: In cellar selection potatoes are picked out which are uniform, smooth, true to type, free from tuber-diseases, etc.; but unless the growing crop is considered, two very important factors are neglected—namely, vigour of the crop and freedom from those diseases which can only be detected in the growing crop; therefore it would seem advisable for the grower to stake the more vigorous hills and save the tubers from those for seed.

Opinions differ somewhat as to the best size of potato to select for seed. However, it is generally agreed that neither very small nor very large potatoes are desirable to plant. Some growers prefer to select tubers from 3 to 8 oz. in weight, with very satisfactory results. If growers would select enough good seed-potatoes to plant a seed-plot each year, even a much greater improvement in the crop would be obtained.

The best methods employed in the selection of seed-potatoes for a seed-plot are: First, hill method; second, tuber-unit method.

In the *hill method* the hills are started from one seed-piece. The vigorous plants are marked and at harvest-time each hill dug separately; those that bear desirable tubers are saved for the next year's seed. In the *tuber-unit method* single tubers are selected of about 5 or 8 oz. in weight, true to variety and type. Each tuber is cut from stem to seed end into quarters of equal size and the four pieces planted consecutively in a unit of four hills. During the summer weak plants are eliminated and at digging-time the harvested units should be put into separate bags. The second year the tubers from each unit are again quartered and the units kept separate. The weak hills are eliminated during the summer and at harvest-time each unit is inspected carefully and the most productive, true to type and variety, saved. The third season the amount of seed preserved will be sufficient to plant a large seed-plot and the selection of one or more of the best pure lines should be made.

In the selection of seed for seed-plots the following points must be kept closely in mind:—

Fig. 12. A sack of well-graded potatoes (original).

(1.) Select only potatoes which are true to type and variety.

(2.) Never select seed from fields in which signs of leaf-roll, mosaic, and wilt are prevalent.

(3.) Never use for seed, potatoes showing a dark ring in the stem-end.

(4.) Discard potatoes showing any signs of scab, *Rhizoctonia*, etc.

(5.) Always treat potatoes with corrosive sublimate or formalin before planting.

Certified Seed.—Every grower should aim to carry on some kind of seed-improvement work. It need not necessarily be seed-selection for a seed-plot, although the best results are undoubtedly obtained by having a seed-plot and then selecting seed from it for the field planting, provided the work is carried on carefully. For the majority of growers, however, the certified-seed plan which is being introduced into this Province for the first time will undoubtedly serve a good pur-

pose, since it will necessitate two inspections of the growing crop and one inspection after digging by an official especially trained in potato-disease identification.

The first inspection of the growing crop is made at bloom-time. Any field which is entered for inspection and contains more than a certain percentage of disease or varietal mixture at this inspection is rejected and at once considered unfit for seed. However, should it pass this inspection, then it is eligible for the second field inspection, which is made just prior to maturity. This inspection is necessary in order to detect any diseases which may have developed since the first inspection. Such diseases may be *Rhizoctonia*, wilt, or late blight. Provided a crop has passed the field inspections satisfactorily, then it is eligible for the tuber inspection. Here again the crop must reach a certain standard in the tubers; if it does not it is rejected, no matter how good the growing crop appeared. The standard for tuber inspection will not allow more than a certain percentage of disease. Potatoes must be reasonably true as regards type, uniformity, and colour, and of good general appearance. Also the crop must be graded so that potatoes are no larger than 12 oz. or smaller than 2 oz. in weight.

Fig. 13. Healthy seed-potatoes (original).

Any crop which passes the three inspections satisfactorily to the inspector will be classed as Grade No. 1 certified seed-potatoes, and each sack for sale will have a suitable tag attached by the inspector, upon which will be stamped the name and address of grower, together with the name of the variety.

Purchasers of certified seed should be willing and ready to pay at least $1 per sack more for such seed than for table stock. They will even then be doubly repaid for such a policy.

Certified potato-seed production is already being carried on in all the chief potato-producing States, and also in some of our own Provinces, because there is a great demand for good, vigorous seed stock free of disease. It is a well-known fact that yield may be very greatly reduced, besides lowering the quality, if diseases are allowed to accumulate.

Arrangements are being made for carrying on certified potato-seed work in British Columbia. The need is urgent if we are to keep out the more serious potato-diseases, obtain pure seed, and regulate the various potato types. At the present time this Province is practically free of such diseases as leaf-roll and mosaic, which reduce the yield so greatly in many countries; therefore it is necessary to take precautionary measures.

The importation of potatoes from some countries has already been stopped because of potato-wart, etc., and it behoves the growers to be prepared for further restrictions. Not only this, if it is possible to grow more and better potatoes it should be done. It will assure the growers higher yields and higher prices. The question is an important one not only for the large growers, but also for the grower who produces potatoes in small quantities.

At the time this bulletin goes to press it will be impossible to have the certified seed standards ready for publication; however, it is our intention to later prepare a circular on certified-seed production, and these standards will be included.

The result of this work will make it possible for good, reliable British Columbia seed-potatoes to be obtained within the Province for the benefit of the public of the Province.

Many of the seed-potatoes offered for sale in the spring of the year are *only the culls from table stock*. The buyer has nothing else but potatoes which are too small to peel, for planting. Some of these small potatoes may come from high-yielding, healthy plants, but the greater part come from small, weak, and diseased plants. The result is "like begets like," and it is not long before the stock runs out.

Change of Seed.—Whether or not it is advisable to change seed every so often is a question which affords a great deal of discussion. The majority of potato-growers believe a change is better; personally, the writer believes that if a grower selects his seed carefully each year a change is unnecessary, provided climatic conditions are favourable. In this respect it is interesting to quote the following experiment carried on by Dr. C. A. Zavitz at Guelph Experimental Station, Ontario: Five varieties of potatoes were grown for twenty-six years in succession without any introduction of tubers from an outside source. Care was taken each year to select, from the crop which was produced, good seed-potatoes for planting in the following spring. No hill selection took place in any year in connection with this experiment. The fertility of the soil probably remained about uniform as in the four year's rotation in which the potatoes were grown; three farm crops were removed from the land; barnyard manure was used once, and no commercial fertilizer was applied. Starting with 1890, the average yield per acre per annum for the five varieties for the five-year periods was as follows:—

	Bushels.
1890–94	133.0
1895–99	212.0
1900–4	237.2
1905–9	208.7
1911–14	211.1

The average for the whole period of twenty-five years was 200.4 and for the last five years 211.1 bushels per acre. The average yields for the second, fourth, and fifth periods were comparatively close. The yield for the first period was low and that for the third was high.

The average yield per acre of the five varieties in 1915 was 30 bushels per acre greater than that of 1890. The results show that potatoes have been grown on the one farm for twenty-five years without change of seed, with a resulting increase in production. When a satisfactory yield can be obtained with a certain variety for a period of years, and that variety continues from that time to yield well, it would seem undesirable for any one to change seed under such conditions. Every grower should experiment for himself along this line. The so-called running-out of potatoes is due to poor selection, and therefore a change of seed in this case would be of decided advantage.

Immature Seed.—In certain districts it may be well to obtain seed regularly from northern districts or districts where the seed is slightly immature. This would apply more to districts where the summers are dry and the crop does not retain its vigour. Experiments have been carried on at several experimental stations in which potatoes have been planted at various dates in May, June, and July in one year and the product all planted on the same date the following year in separate plots; the results have been greater yields from that crop the seed of which came from the July-planted potatoes of the previous year; the reason being that the July-planted crop of the first year produced immature potatoes.

Figs. 14, 15. A method of cutting seed-potatoes when eyes are numerous (original).

Another striking instance of the value of immature potatoes for seed is given by Ontario. Seed produced in Northern Ontario produces greater yields when planted in Southern Ontario than does the home-grown seed, the reason being that the northern-grown seed is produced in a cool climate, where the crop gets cut off early by frost and therefore does not mature. The tubers are checked in growth, but are full of vitality.

In Great Britain seed-potatoes from the south of England do not give as high yields as those from Ireland and Scotland; the latter countries being cool and the former warm and dry.

British Columbia, being northern to the United States, should be in a position to supply seed in large quantities to that country.

Cutting Seed.—Many machines have been invented for cutting seed, but none are able to give as good results as the hand-knife, because where potatoes are cut

by hand a closer examination can be given the seed, the diseased potatoes readily avoided, and a better division of the eyes can be secured. When seed-potatoes are cut by hand a free or stationary knife may be used. The knife that is stationary is stuck up through a board so that the blade is in a handy position, with the edge pointing out. By this method potatoes can be cut faster than with the free hand, but the work accomplished will not be as satisfactory.

In cutting potatoes with the free hand no hard-and-fast rule can be given. Opinions differ as regards the best way to cut potatoes. It rests with the man cutting the potatoes to use his own judgment. The writer has several ideas, all of which he considers satisfactory. In cutting the ordinary run of potatoes where the

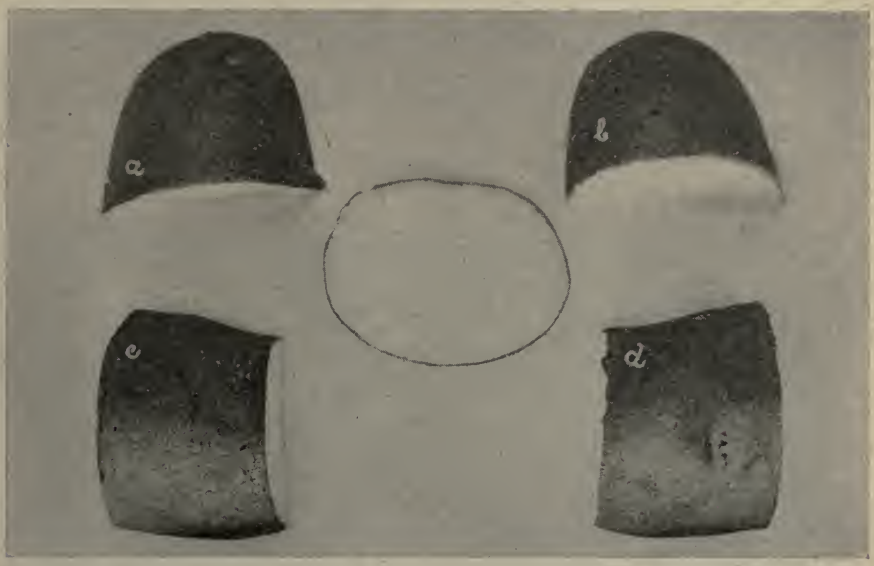

Fig. 16. Potato as shown in Fig. 15 when cut (original). Note the disease-free stem-end.

Fig. 17. Potato as shown in Fig. 14 when cut (original). Note the discoloured stem-end; affected potatoes should not be used for seed.

eyes appear similar and are all at about the same stage of growth, the following method is preferable: First, cut a thin slice from the stem-end. This is essential in order to see if stem-end rot is present, otherwise an infected tuber might pass unnoticed. If disease is present in the stem-end the whole potato should be immediately discarded. When cutting seed-potatoes it is desirable to have an extra knife and a jar of disinfectant at hand, so that if a diseased tuber is cut into, the knife in use may immediately be immersed in the disinfectant and the other knife used. After taking the stem-end slice off, cut the tuber longitudinally, splitting the seed-end; now cut crosswise, making the sets of as near equal size as possible (Figs. 14, 15). A 2-oz. set with two good eyes to a set is generally conceded to give best results (Figs. 16, 17). The person cutting should therefore watch the eyes carefully, because more than two eyes tend to increase the percentage of small tubers.

After cutting the thin slice off at the stem-end many people prefer to begin cutting off pieces diagonally across the tuber until just enough is left at the seed-end to make two pieces; this piece should be split through the middle (Fig. 18). This latter method is more adapted to varieties with few eyes and the former method to varieties with many eyes.

Fig. 18. Method of cutting seed-potatoes when eyes are few (original).

The person who is cutting seed-potatoes should always bear in mind that uniform, blocky sets are desirable, since these will not rot as easily as others, and also these pieces will work better in the horse-planter.

Care of Seed after Cut.—Potatoes should be planted as soon as convenient after being cut. Most growers take care not to cut a very great quantity of potatoes ahead of the planter, for fear that rains may cause delay or the potatoes dry out. Where it is impossible to plant tubers immediately after being cut they may be covered with land-plaster, gypsum, or sulphur, to prevent excessive drying. Cut potatoes should be kept away from sun or winds.

Size of Set to Plant.—Where cut seed is used for planting a 2-oz. seed-piece is usually considered the best size. This statement is fully borne out in an experiment carried on by Dr. Zavitz at Guelph. Sets were planted for five years weighing 1/16 oz., ⅛ oz., ¼ oz., 1 oz., 2 oz.; one eye was left in a piece and the pieces planted 1 foot apart in the rows. There was a variation in yield from 47.5 bushels (1/16 oz.)

to 173.9 bushels for 2-oz. seed. Subtracting the amount of seed used, the former gave 46.2 bushels and the latter 132.7 bushels.

The system of cutting out the eyes of the potato to plant is not good practice, since there is not enough plant-food present to support the young shoot till it develops a root system.

The Number of Eyes to a Set.—Two eyes to a set is usually conceded to give better results than even one or three eyes. Where a larger number of eyes are present the percentage of marketable tubers is greatly reduced; this is especially true when the seed-end of the potato is planted, although the potatoes from the seed-end will be earlier.

Whole vs. *Cut Seed.*—In districts where the land is wet or poorly drained whole potatoes are preferable to cut seed, since these rot less easily. Again, whole potatoes are less subject to internal infectious disease than are cut seed. Also, whole seed will sprout earlier and give larger yields. On the other hand, the percentage of marketable potatoes will be smaller when whole seed is planted than with cut seed.

Small whole potatoes are often used for seed because they are much cheaper, although they are only the culls from the marketable potatoes. This practice is not a desirable one, since it is unknown whether these small potatoes came from healthy or unhealthy hills.

Amount of Seed required per Acre.—From what has gone before it will be readily understood that it is impossible to give a definite statement regarding the amount of seed to use per acre. This will vary according to the size of the piece planted, distance between rows, and whether seed is large whole, medium whole, small whole, or cut seed. From 600 to 1,200 lb. is usually required to plant an acre of potatoes when rows are 3 feet apart.

PLANTING.

Potatoes may be planted by the hill or row method and by machine or by hand. The various methods will be described here.

Hill and Row Method.—Fields of potatoes may be planted in hills or drills, and they may be planted by hand or by a machine-planter. The hill system of planting is usually practised in gardens and the drill system in fields. In the hill system two or three sets may be used to the hill and the rows are about 30 to 36 inches each way. The advantage of this system is that it allows cultivation of the crop both ways, thereby lessening the weeds. This method is better adapted to soils which are lacking in plant-food. The disadvantage of this method is that the yield is smaller.

In drill-planting the rows are from 30 to 38 inches apart; 36 inches is usually allowed. The distance between the hills in the row varies from 12 to 18 inches apart; 16 inches is probably the most satisfactory. The distance between seed-pieces depends on the size of the sets, the supply of moisture, and fertility of the soil. In irrigated districts the rows should be farther apart, but seed-pieces may be closer in the row.

Machine and Hand Planting.—Fields planted with a horse-planter have given as good yields as those planted by hand, where large areas have been compared. A machine-planter (Fig. 19) should be used wherever practicable, as it opens furrows, drops seed-piece, and covers up without exposing bottom of furrow to dry air for very long. The ridge left by the planter affords a guide for the first cultivation. Where the soil has been well prepared the planter will do excellent work. There are various makes of planters on the market, and there are two distinct types: (1) The picker (Fig. 20); (2) the two-man machine (Fig. 21).

The picker-machine is operated by one man. The pieces are picked up on steel points, from which they are dropped in the furrow. The platform type of machine is operated by two men, and a full planting can be obtained if the man who fills the sections in the feeding-platform is thorough in his work. For all planters it is better to have seed-pieces of uniform shape and size.

Fig. 19. A machine potato-planter in operation (courtesy of Ironage Canadian Machinery Company).

Fig. 20. A picker type of planter.

Where potatoes are planted by hand it is customary to make the furrows with a single or double mould-board plough, to drop the potatoes by hand immediately to prevent drying-out, and then close the furrow with the plough. In gardens holes can be made to the required depth with the hoe; sets are immediately dropped by hand and then covered with soil.

Where potatoes are dropped by hand the rows should be marked off first. In doing this it is necessary that the rows be made as straight as possible. Crooked rows result in damage to the potato-plants by the cultivator-teeth later in the season.

Hand-planting is to be preferred to machine-planting: (1) Where labour is cheap; (2) in stony land; (3) where the area to be planted is not large.

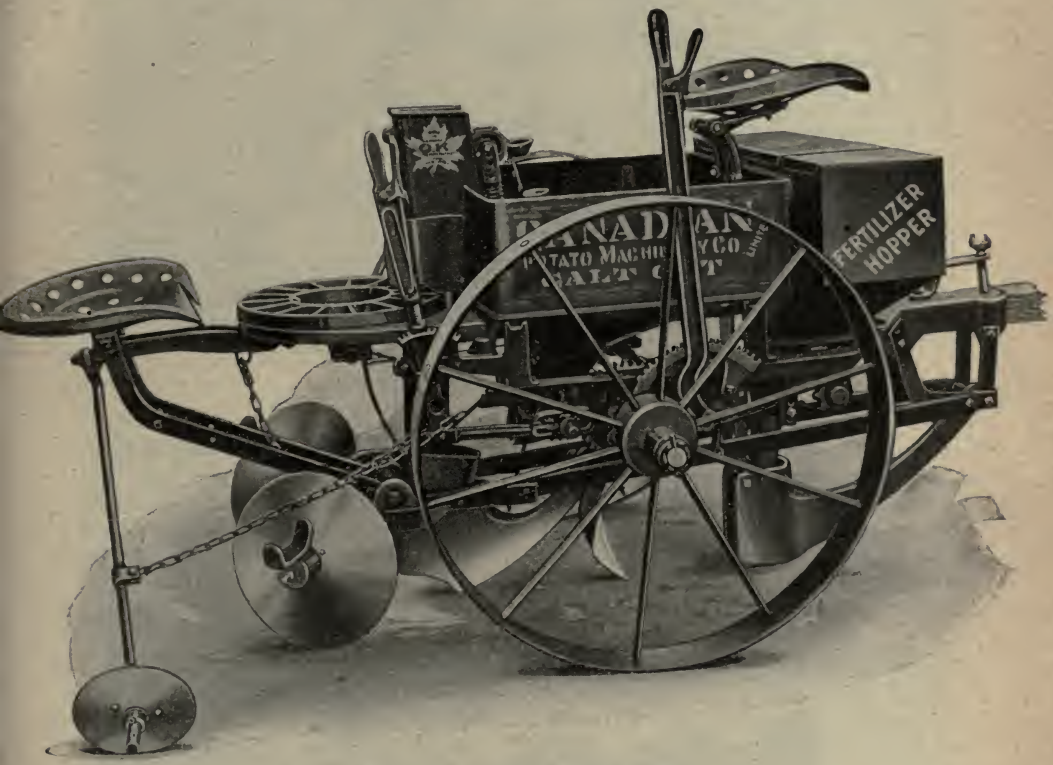

Fig. 21. A two-man type of planter.

Machine-planting is to be preferred to hand-planting, because: (1) Seed does not have the chance to become dried out before covering; (2) seed is planted to a more uniform depth; (3) seed is dropped in straight rows, which means closer cultivation; (4) work is accomplished quicker, and therefore of great benefit to the grower of large acreages.

Planting Potatoes under Sod. — Sometimes potatoes are planted in freshly ploughed sod and excellent results obtained. While the ploughing is being done the sets are dropped every third furrow by a second party and then covered with the plough when the next furrow is made. After planting the land is disk-harrowed and rolled if necessary.

Time to Plant.—This varies greatly with different districts. It depends on the market for which the crop is grown, also soil and climatic conditions. In some sections it pays to get the crop in just as soon as the land is warm enough, in order that it may be possible to get the potatoes on the market early and receive the higher price. (Each grower can best judge for himself the proper date for planting in his district.) Where the season is short, late varieties should be planted in

time to ripen before frost. There are many dangers from late planting, chief of which are: (1) Late blight; (2) injury from early frost.

Depth of Planting.—The depth to plant varies with conditions. Very deep planting is open to objection because of the increased labour of harvesting and the

Fig. 22. Typical Jersey Royal potatoes (original).

danger of a poor stand when weather conditions are unfavourable. Very shallow planting reduces the yield and injures the quality of the crop. The most suitable depth for planting depends somewhat on the character of the soil and upon the method of cultivation. If the soil is warm and fairly moist the potatoes should be planted deeper than if it is cold and wet. Therefore early potatoes should be planted shallower than late potatoes. In unirrigated land potatoes should be planted deeper than in irrigated land. The best depth for planting potatoes is from 3 to 6 inches.

Fig. 23. A suitable potato-cultivator (photo by A. Ingrams).

Cultural Methods after Planting.—Harrowing of the land may begin as soon as necessary after seed is planted. The common drag-harrow or weeder may be run over the land at least twice before cultivation of the rows commences. Some damage may be done to the crop by harrowing the potatoes before they are up, but

the loss sustained will be more than offset by having kept the weeds under control at a critical stage.

In cultivating potatoes the first time after they are up the cultivator should be run as deep and as close to the row as practicable, and a little dirt should be thrown into the rows to help control the weeds. There are several types of cultivator for this work—the one-horse cultivator, two-horse cultivator (Fig. 23), and four- or six-shovel cultivator. All of these will do satisfactory work when used in the right place. Subsequent cultivations should be shallower and carried on every ten days or so. In dry weather the cultivation should be more frequent than in wet weather, the object being to conserve as much moisture as possible. Cultivation may be continued, if plants are not too large to interfere, until bloom-time. The number of cultivations during a season runs from three to six.

In dry districts level cultivation should be practised. In irrigated districts or districts where there is plenty of moisture during the growing season it is well to set the cultivator in such a way as to work the soil toward the row.

HILLING POTATOES.

When potatoes are grown in districts where the summers are comparatively dry, hilling of the crop is likely to be detrimental owing to the loss of soil-moisture which will take place. If potatoes are likely to be sunburned, the rows may be slightly ridged at the last cultivation.

In irrigated districts or districts where there is plenty of moisture it may be well to hill the potatoes. The soil will thus be warm and loose, and therefore favourable for the production of good tubers.

IRRIGATION.

Fig. 24. An irrigated potato-field near Kamloops (original).

The secret of raising good potatoes under irrigation appears to lie in being able to keep the plants growing vigorously from the beginning with no checks. Water should be applied so that too sudden growth will not be stimulated at any time.

The main point in the irrigation of potatoes is a thorough preparation of the soil. Deep fall ploughing of alfalfa or clover sod with the manure added to the previous crop is preferable.

When the potatoes have grown large enough so that the rows are visible, the land is marked for irrigation and irrigated with about 4 acre-inches, then cultivated deeply, decreasing the depth during the season as it advances. Loose gravel soils need small amounts of water at frequent intervals, say every two weeks; clay loam, larger amounts at longer intervals. On good soils fair crops of potatoes can be grown with 12 acre-inches of water, but on gravelly soils 18 to 24 inches would be better. The need for uniform moisture must always be kept in mind, since it has a tendency to keep the ground cool, especially when shaded by the tops, and thus prevent second growth starting from a premature ripening. It is seldom advisable to irrigate after bloom-time. The best plan is to plant potatoes early and start them on the natural moisture if possible, as this is much stronger in plant-food than when diluted with irrigation-water.

HARVESTING.

The time of harvesting is influenced by weather conditions and the kind of potatoes grown. Potatoes, except those for the early market, should be left in the ground until the tops are thoroughly dead, if possible. Where potatoes are to be saved for seed it may be profitable to dig when potatoes are slightly immature. The weather should be dry and cool at harvesting-time.

There are three methods of harvesting: (1) Hand-digging; (2) potato or common plough; (3) potato-diggers (Fig. 25).

Hand-digging is used in small areas, in early potatoes, and in rough land. A four-tined potato-fork, an ordinary six-tined fork, or a six-tined fork with tines bent half-way are best. The person digging usually takes two rows at a time, and throws the potatoes together in the space between the two rows. Care should be taken in order to bruise as few potatoes as possible.

Fig. 25. Potato-digger in operation (courtesy of Ironage Canadian Machinery Company).

Digging by ploughs is not to be recommended, as this cuts or injures many of the tubers, and many potatoes are covered up with soil. Where a large area is to be dug a machine-digger is essential. There are several types of machine-diggers on the market. The one commonly used in this country has a steel nose which runs under the row and lifts potatoes and soil over a carrier-chain, which separates tubers from the soil (Fig. 26). Another type of digger less commonly used has a revolving frame with forks which dig into the ground at right angles to the row (Fig. 27). Potatoes and soil are thrown on top of the ground.

Potatoes should not be left on the ground overnight, for fear of frost or rain.

If potatoes are affected with late blight it is advisable to leave them on the ground as long as possible, because the diseased tubers will show signs of rot before they have to be taken up on account of frost, and they need not be picked up at all. The healthy tubers should be put in a cool, well-ventilated cellar.

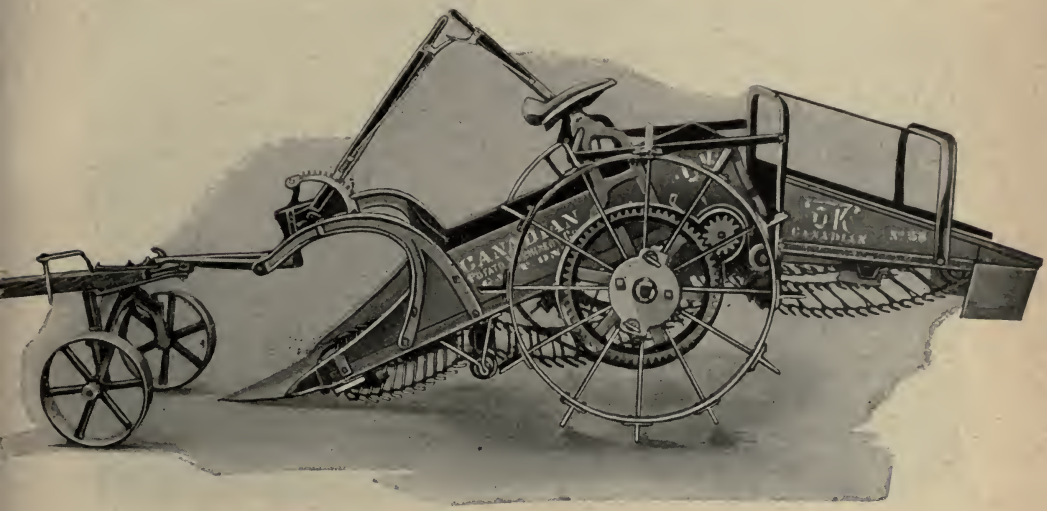

Fig. 26. Side view of a steel-nose potato-digger.

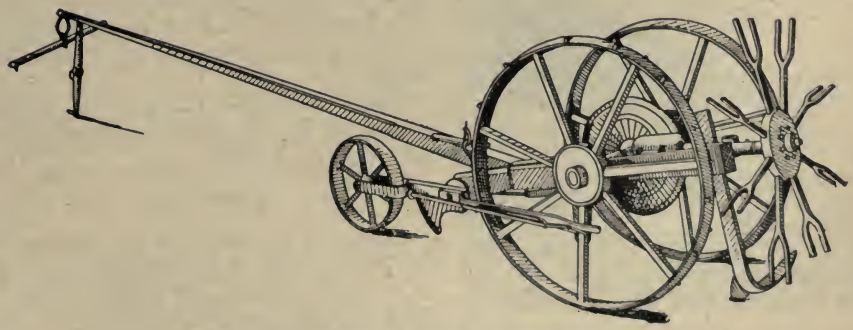

Fig. 27. Fork potato-digger (after Macoun).

PICKING, SORTING, AND GRADING.

Potatoes should be left on the ground to dry, if necessary, before picking up is commenced, but not long enough to get sunburnt. Potatoes are conveniently picked up into bushel baskets and then these are emptied into sacks. Two men should work together to accomplish quickest and best results (Fig. 28).

Fig. 28. Picking up potatoes near Chilliwack, B.C. (photo by A. Ingrams).

When the weather will permit, potatoes may be sorted in the field; however, rather than take chances and in order to do more careful sorting, it is preferable to do the sorting inside, especially in the case of potatoes for seed.

Potatoes may be run through a potato-grader (Fig. 29). The size required to sort depends on the market demand. While the potatoes are going over the sorter, diseased, irregular, and other undesirable tubers can be picked out. When a potato-grader is not available sorting may be done by hand. This method is slow, but satisfactory. All potatoes should be sorted before being permanently stored for winter.

Fig. 29. A potato-sorter (courtesy of Aspinwall Canadian Machinery Company).

There are several kinds of potato-graders on the market at the present time which do good work.

STORAGE.

In storing potatoes, whether for seed or for table stock, it is important to store only sound, clean, dry potatoes and to keep them in dry, cool, dark, and well-ventilated houses. Great losses occur annually because potatoes are stored in wet, poorly ventilated buildings.

Storage of Seed-potatoes.—The chief consideration and the determining factor of success as against failure for the potato-seed grower is the problem of storage. It is essentially an important factor with the grower who practises careful selection from year to year, because he must preserve his stock in the very best possible condition.

Potatoes for seed purposes should be handled very carefully to prevent them from becoming bruised or skinned. Together with this, it is essential that they be perfectly dry before being stored. Seed-potatoes should not be stored in old sacks or in unsanitary cellars. The storage-house should be cool and well ventilated in order that the seed may not sprout, the best temperature being about 36° F. It is especially desirable to control the temperature and moisture in the storage of seed-potatoes, since there is undoubtedly a close relation between these factors and disease.

Storage of the General Crop.—Every potato-grower should make provision for storing at least part of his crop. If he grows a large acreage of potatoes each year, then it would pay him to build a permanent potato-storehouse, but if, on the other hand, the acreage is small, then it will be cheaper for him to store in the cellar or pit. The greatest difficulty encountered with pitting is that the potatoes cannot be gotten at when the weather is cold and the grower never knows just what the temperature is. The best storage temperature for the general crop is around 36° to 40° F. Each storage-house should be provided with a thermometer. Where temperature is too high conditions are favourable for disease, and potatoes will also be likely to sprout. It has been estimated that when potatoes have sprouted badly there is a loss of from 10 to 40 bushels per acre. In putting potatoes into storage it is better to spread them out in layers, in order that they may cool off better.

Construction of Storage-houses.—In constructing a storage-place for potatoes, certain essential factors must be continually borne in mind: (1) Maintenance of low temperature; (2) protection from frost; (3) avoidance of a wet and stagnant atmosphere; (4) protection from heating; (5) protection from change of temperature.

The amount of protection from frost varies with the severity of the climate. In British Columbia, the Lower Mainland, and Island regions the same construction as demanded in the Interior regions will not be required.

In the early fall and spring the storage-house is kept cool by admitting the cool night air and by closing the building during the day.

Types of Storage-places.—A cool, well-ventilated cellar or root-house is recommended for storage of potatoes. If there is not good ventilation, slats can be nailed a little apart about 5 or 6 inches from the wall. A false floor with cracks between the boards can be put 6 inches above the permanent floor. This allows the air to circulate in and around the pile. If the pile is very large, slatted ventilators can be placed here and there from top to bottom. The temperature should be as low as possible without freezing, and at the same time the air should be as dry as possible.

Storage-pit.—(Fig. 30.) In sections of British Columbia the potatoes are often pitted. It is essential to have good drainage, and this may be found on a ridge or slope having a loose or gravelly subsoil. The site must be well protected in order to prevent it being exposed to prevailing winds, which penetrate the soil with extreme cold during the winter. There is just as much danger from loss in this case as there is if the site is such as will warm up rapidly with a thaw, then freeze again.

Pits should be dug about 12 to 18 inches below the surface. The depth depends upon the moisture in the soil; therefore a deeper pit can be made in dry places. A convenient size for a pit is 8 by 18 feet. The tubers should be placed to a depth of from 3 to 4 feet. A layer of straw should be placed in the bottom of the pit; also a layer of straw should be placed over the potatoes to a depth of 6 to 8 inches; then as the weather grows colder soil is thrown over this to prevent freezing. This should be done gradually as winter advances. The depth of the soil-covering varies with the temperature. Districts having winter temperatures as low as zero will need over a foot of soil, with a greater depth, especially at the base, as the temperature goes below this mark.

Pits demand ventilation to keep the vegetables from rotting, and this is done by leaving holes at intervals of 6 to 8 feet where tufts of straw are inserted.

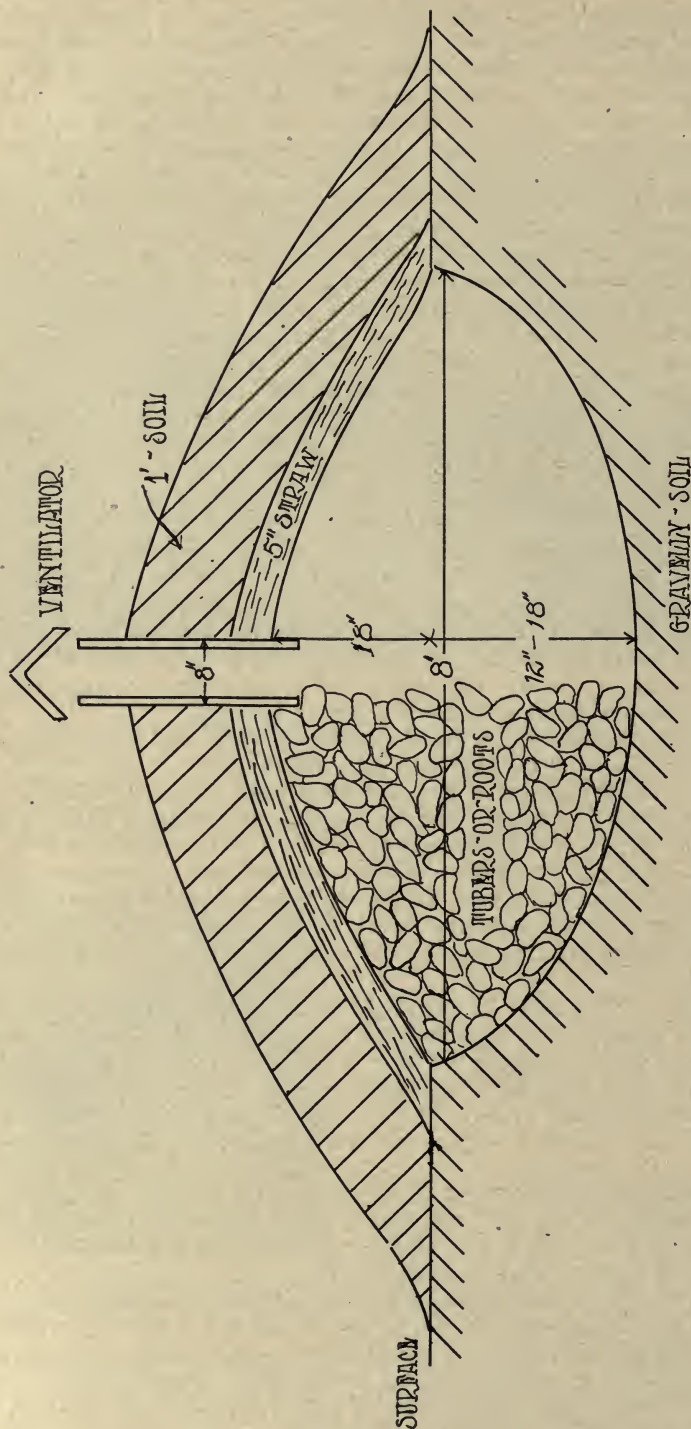

Fig. 30. Diagram showing the section of the storage-pit (original). Note the cupolas.

Cupolas (as shown in Fig. 30) are sometimes used for the same purpose and thus prevent the entrance of moisture. These should have straw placed in the opening upon the approach of winter.

Shrinkage in Storage.—Potatoes lose weight a great deal in storage. The loss is slow at first, amounting to about 6 or 8 per cent. during the first six months. After that the loss amounts to about 5 per cent. per month.

MARKETING.

Before growers in a district can expect to obtain successful markets their first aim should be to grow one or two standard varieties, so that they can ship in car-load lots potatoes of the same variety or type. Secondly, they should grade their crop well; and, thirdly, they should practise co-operative marketing. If the best results are to be obtained from co-operative effort, two factors are essential: (1) That the members always remain loyal to their association; (2) that the association have a competent manager of good business ability.

Questions are often asked such as these: "When shall I market my crop?" "Will it pay to sell now or hold until spring?" It is very difficult to answer such questions. If the price is a fair one it may be wise to market the crop in the fall, because if the grower waits until spring he is taking a big chance as regards price, and at the same time he may lose many potatoes in storage. On the other hand, if the farmer is pressed for time in the fall, he can use his time to better advantage than marketing potatoes; also in the winter he will have more time for sorting. In any case the potato-buyer will usually only take a certain quantity in the fall.

DISPOSAL OF CULL POTATOES.

There is too much of a tendency for growers to use those potatoes for seed which have been thrown out as unfit for table stock (culls). Such a practice is a very serious one and should be guarded against if growers wish their potato-growing to reach a high standard.

There are various methods for disposal of those cull potatoes. In some countries they are used for the manufacture of alcohol, starch, or stock-food. In this country we have at the present time to resort to feeding them to stock; this is our most profitable and best way to dispose of them. Professor W. A. Henry, Director of the Agricultural Experiment Station, University of Wisconsin, in his well-known text-book on "Feeds and Feeding," makes the following statement in regard to potatoes as feed for stock: "They are fed chiefly to pigs, but can also be given in limited amounts to cattle, sheep, and horses as a partial substitute for grain. For pigs they should be steamed or boiled and fed with concentrates. In various trials 340 to 442 lb. of potatoes have saved 100 lb. of grain. The bitter-tasting water in which potatoes are cooked should be thrown away, likewise all unripe tubers and the sprouts, which contain considerable poison. For horses potatoes may be fed cooked or raw, in amounts up to 17.5 lb. per head daily. For dairy cows a heavy allowance of potatoes produces milk of poor flavour. Not over 33 lb. of cooked potatoes should be fed daily and less of the raw tubers."

PREPARATION OF CARS FOR SHIPPING POTATOES.

Many car-loads of potatoes are in an inferior condition when they reach their destination on account of lack of knowledge as to the best methods of loading and shipping.

For long-distance shipments crates are the most satisfactory containers and are absolutely necessary for ocean transportation. The end pieces of the crates should be hexagon shape, which allows for better ventilation when storing a large quantity together.

In dealing with potatoes in sacks, when loading into freight-cars it is desirable that the car be provided with a false floor to give good ventilation in order to allow better circulation of the air in the event of the car being heated, and also to prevent freezing.

Recent investigations regarding loading of cars have been made by the Bureau of Markets, United States Department of Agriculture, and it is from their publication of "Lining and Loading Cars" that a great deal of the information which is to follow has been extracted.

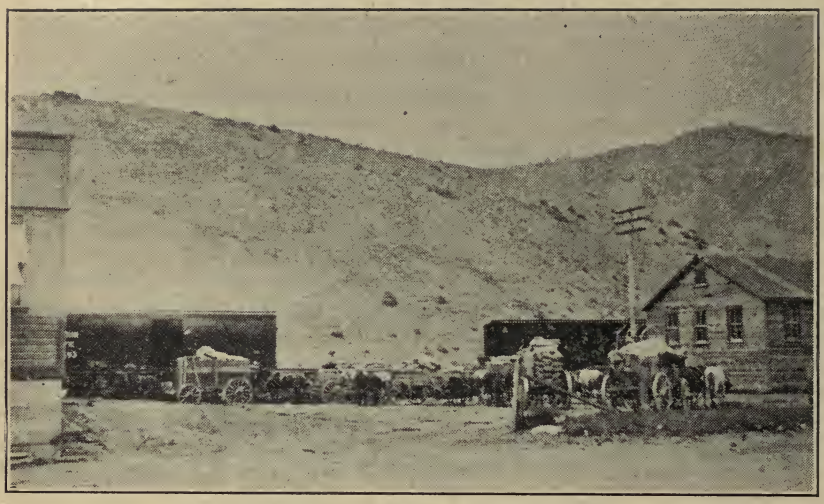

Fig. 31. Loading potatoes at Ashcroft (original).

In loading potatoes in cold weather care must be taken to prevent freezing if loss is not to ensue. According to an investigation made by the Bureau of Markets, approximately 75 per cent. of all cars prepared to protect potato shipments in cold weather are lined or loaded incorrectly.

When cars are being prepared to protect potatoes against freezing in transit it is important to remember that warm air weighs less than cool air. Warm air from the heater therefore rises directly to the ceiling over the heater and there spreads out along the ceiling. If the warm air is not allowed to get down to the floor it will pile up between the potatoes and the ceiling, and the top potatoes will become overheated and blackened at the centre; at the same time the warm air is kept from the floor of the car and the potatoes may freeze. (Fig. 32.)

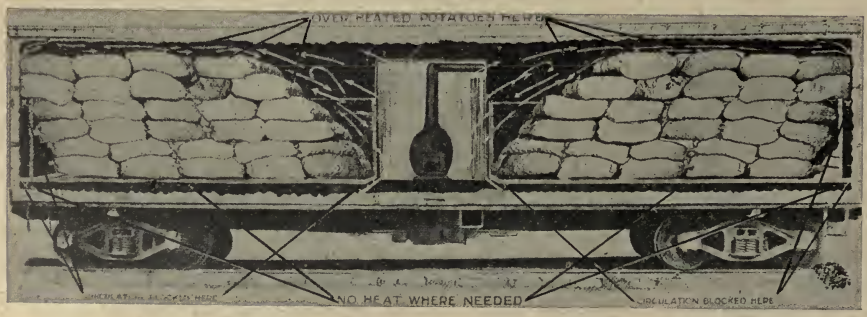

Fig. 32. Improper method of loading potatoes (after Bureau of Markets, U.S. Bulletin 1091).

In order to overcome this a complete air-passage the full width of the car must be kept open around the load (Fig. 33), and the following points must be borne in mind:—

(1.) The potatoes must not be close enough to the ceiling to block any part of the circulation.

(2.) There must be a large, unobstructed opening for the warm air to pass down to the floor after it has spread the length of the ceiling from the heater.

(3.) The false floor must be so constructed that this warm air can pass under it at all points.

Fig. 33. Proper method of loading potatoes (after Bureau of Markets, U.S. Bulletin 1091).

Loading.—Cars should be heated for at least six hours directly before loading, and longer, if possible, when the outside temperature is low. In loading sacked potatoes the sacks should not come closer than 8 inches to the ceiling when loaded.

Fig. 34. Potatoes at the floor should be loaded away from the sides and ends of car (after Bureau of Markets, U.S. Bulletin No. 1091).

The potatoes at the floor should be loaded not less than 6 inches away from the sides and ends of the car. (Fig. 34.) Where potatoes are stood up in the car each sack of potatoes should be placed about 4 inches apart in the row, and the sacks in the row above should be placed over the 4-inch space between the sacks in the row below. This same method of loading applies to sacks which are being laid flat. If this scheme of loading is carried out carefully there will be uniform ventilation throughout the whole car and ample opportunity for the warm air to be distributed equally in the event of it being necessary to heat the car. Great care should be exercised to exclude any of the rots to which potatoes are subject if they are intended for long shipment or storage.

THE COST OF GROWING POTATOES.

Questions are often asked regarding the cost of producing an acre of potatoes. Such questions are difficult to answer, and in fact cannot be answered accurately. Many factors may influence the cost of production per acre. The farmer who adopts the best cultural methods, treats his seed, sprays his crops, and selects his seed carefully will naturally have a higher expenditure than one who does just what is essential to plant-growth and no more.

Table VIII. has been drawn up as a very approximate estimate, showing the expenditure of two types of growers. The one, a careful grower, is represented by the letter A, and the other, a careless grower, is represented by the letter B. Since the number of hours required to do a piece of work remains more nearly the same from year to year than do labour charges, it has been considered wise to roughly estimate the number of man and horse hours required for each operation and to include them in the table. The cost of man-labour has been calculated at 50 cents per hour and the cost of horse-labour at 25 cents per horse per hour, or 50 cents an hour for the team. Of course, where labour is hired by the month or year, charges would be somewhat lower than those given.

Table VIII.

	A.			B.		
	Hours of Labour.		Cost.	Hours of Labour.		Cost.
	Man.	Horse.		Man.	Horse.	
Barnyard manure, 15 tons, hauled and spread	15	30	$ 52 50	..	..	.....
Ploughing	8	16	8 00	8	16	$ 8 00
Harrowing, disking, etc.	5	10	5 00	3	6	3 00
Seed	..	..	40 00	..	..	25 00
Treatment of seed, including cost of material	1	..	3 00	..	..	.....
Planting seed by machine	5	5	3 75	5	5	3 75
Cutting seed	16	..	8 00	10	..	5 00
Harrowing after planting	4	8	4 00	1½	3	1 50
After cultivation and hilling	12	24	12 00	6	12	6 00
Hoeing	16	..	8 00	..	..	.....
Preparation and spraying of Bordeaux	8	8	8 00	..	..	.....
Cost of material	..	..	3 40	..	..	.....
Digging by machine	4	8	4 00	2	4	2 00
Picking up potatoes	25	..	12 50	12½	..	6 25
Hauling to storage	6	12	6 00	3	6	3 00
Sorting and marketing	45	16	26 50	20	8	12 00
Totals	170	137	$204 65	71	60	75 50

NOTE.—All charges are based on prices for 1920.

It will be observed that depreciation in machinery, rent of land, etc., have not been accounted for; therefore, if these factors were brought into consideration, the

cost of production per acre would be somewhat higher than the figures already given. The table as given, although it may be a little out in places as regards number of labour hours and cost, nevertheless serves as a comparison between two types of growers, and illustrates how the cost of production per acre may vary considerably and the difficulties encountered in answering such a question as: "What does it

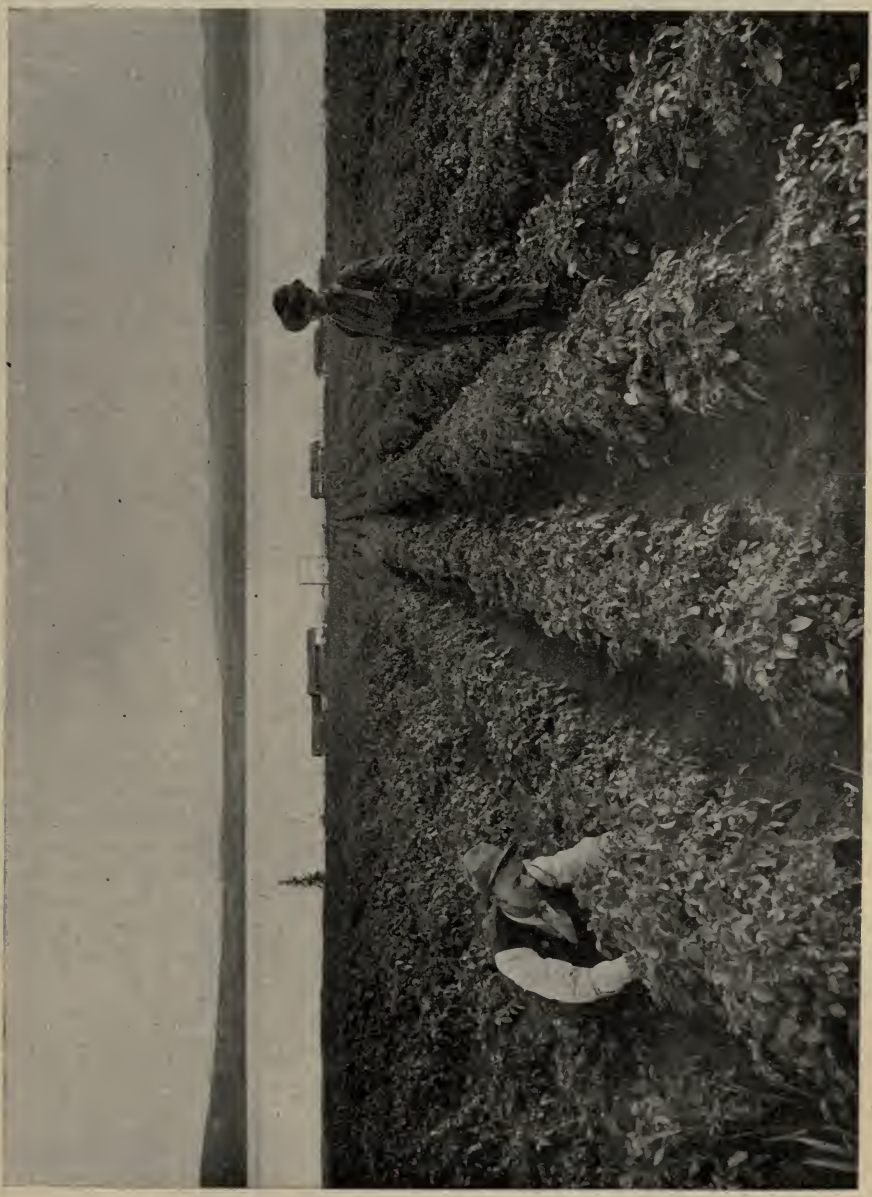

Fig. 35. Potatoes on Francois Lake (original).

cost to produce an acre of potatoes?" According to Table VIII., it will cost grower A $204.65 to produce an acre of potatoes and grower B $75.50 under present conditions. Provided, then, that both growers have a desirable potato-soil, and that climatic conditions are favourable, grower A will get a yield of 10 tons of marketable

potatoes to the acre and grower B 3 tons to the acre. The matter that is of importance now is: What does it cost each grower to produce 1 ton of potatoes?

The reader is referred to Table IX. for this information.

Table IX.

Grower A.		Grower B.	
Cost of production per acre ..	$204 65	Cost of production	$ 75 50
Yield of 10 tons at $40	400 00	Yield of 4 tons at $40	160 00
Profit per acre	195 35	Profit per acre	84 50
Cost per ton	20 46	Cost per ton	18 87

It will be observed that there is a differenec of $129.15 in the cost of production per acre of the two growers; nevertheless, there is only a difference of $1.59 on the cost per ton. Furthermore, grower A reaps a profit of $195.35 per acre and grower B $84.50; however, it costs grower A $20.46 to produce a ton and grower B $18.87. In other words, grower A obtains a profit of $110.85 over grower B because he gets a yield of 6 tons more per acre than grower B, although it costs him $1.59 more per ton to produce it. Therefore grower A reaps a profit of $110.85 over grower B for $9.54 invested. This undoubtedly is a good investment. It is in this light that growers should consider the cost of production for any crop.

The following factors illustrate how the profits per acre may be increased under normal conditions:—

(1.) Planting crop in a suitable soil. A well-drained sandy loam is preferable to a heavy clay.
(2.) Practising careful selection of seed.
(3.) Growing a standard variety.
(4.) Treatment of seed for scab and *Rhizoctonia.*
(5.) Thorough preparation of the soil.
(6.) Good cultural methods.
(7.) Spraying for diseases and insects when necessary.
(8.) Careful digging and handling of crop.
(9.) Efficient storage.
(10.) Careful and thoughtful marketing.

FIELD-CROP COMPETITIONS.

Much good work towards the improvement of the potato in British Columbia has been accomplished through field-crop competitions; these competitions being carried on in connection with the various Farmers' Institutes throughout the Province.

The announcement of these competitions was first published in a bulletin form containing a brief description of the most approved cultural methods, and copies were distributed to all members of Farmers' Institutes. The competitive spirit led large numbers of farmers to handle their potato-crop along approved lines. Many valuable demonstrations resulted, the more noticeable of which were fertilizing tests, the value of Bordeaux as a spray, and the formalin treatment for scab. The minimum size of a plot entered in the competition was one-half acre. Awards were based on the following field score:—

	Points.
General appearance, considering:—	
(1.) Method of planting, stand of crop	7
(2.) Vigour of growth	8
Freedom from blight, scab, and insects	20
Method and thoroughness of cultivation	20
Purity of variety	10
Apparent yield, considering:—	
(1.) Number, weight of marketable tubers per hill	15
(2.) Quality, colour, shape, and smoothness	10
(3.) State and uniformity of maturity and freedom from sunburn	10
Total	100

The benefits derived from field-crop competitions are readily noticeable upon visiting those districts which have conducted competitions for a number of years, and there is striking evidence of what can be done by selection of seed and seed-plot work with such an important crop as potatoes. (Fig. 36.)

Fig. 36. A group of enthusiastic growers and the judge examining a potato-field entered in a field-crop competition (original).

BOYS' AND GIRLS' COMPETITIONS.

Potato competitions in connection with the Boys' and Girls' Clubs have been going on for some time now and splendid success has been attained. All competitors within the same club district use the same variety of potato and preference is given to one of the standard varieties. The growing crop is judged and scored during the summer according to the following score-card:—

	Points.
Selection and preparation of plot	15
Method of planting	15
Uniformity of stand	10
Method and thoroughness of cultivation and freedom from weeds	25
Freedom from disease—blight, scab, etc.	25
General field conditions	10
Total	100

When the crop is harvested and placed on exhibition it is scored according to the following standard:—

	Points.
Uniformity of exhibit: Uniform in size, colour, shape, and character of eyes	20
Trueness to type: Each potato typical of the variety to which it belongs	10
Shape of tuber: Flat, round or oval preferred	15
Size of tuber: Medium-sized (about 10 oz.)	15
Eyes: Well marked, not too deep or too numerous	5
Skin: Of a colour typical of the variety, healthy, fairly thin, not sunburned	5
Texture: Fairly fine and brittle	5
Soundness: Flesh not diseased or hollow, no discolorations	15
Freedom from blemishes	10
Total	100

Instructions regarding type of soil, preparation of the plot, and selection of seed, together with information regarding seed-treatment, the cutting and planting of seed, cultural methods, spraying, and digging, are fully given to the boys and girls.

VARIETIES.

Standardization of Varieties.—If good markets are to be obtained it is absolutely essential that standard varieties be grown. Many times good markets are lost which would otherwise have been obtainable if a district had been growing a standard variety.

Oftentimes it is difficult to get a car-load of standard potatoes from a district because so many varieties are being grown, whereas if all were growing the same variety little difficulty would ensue. The importance of standardization cannot be overemphasized.

Production of New Varieties by Cross-fertilization.—In the improvement of field crops two general methods are followed: (1) Selection; (2) artificial cross-fertiliza-

Fig. 37. A good display of Gold Coin potatoes (original).

tion. The method which is more simple to understand and undoubtedly within the reach of every potato-grower is "selection." This implies the improvement of the variety being grown by a careful selection of those tubers which are of good type and quality, sound and free from disease. Since selection has been dealt with in another part of this bulletin, only artificial cross-fertilization or hybridization will be discussed here.

Fertilization implies sexual reproduction. When the ovules of a flower are fertilized by pollen from the anthers of the same flower, or by pollen from another flower on the same plant, or from pollen produced from cuttings, this is called self-fertilization.

Cross-fertilization takes place when the ovules of a flower are fertilized by pollen from another flower on a distinct plant of the same species. Some plants,

such as corn, naturally cross-fertilize through the agency of wind, etc. On the other hand, such crops as wheat, oats, and potatoes have to be cross-fertilized artificially in order to produce new varieties. This method of improvement, however, should be left to experiment stations to follow out.

The object of artificial cross-fertilization is not merely to produce new varieties, regardless of their merits, but rather to produce varieties in which certain good, desirable points of one variety have been combined with certain good desirable points of another.

The following description is the breeders' ideal for a good potato:—

"A good potato should be true to variety, of good quality, disease-resistant, a good keeper, of desirable colour of flesh and skin, shallow-eyed, and smooth outline. It should be mealy and show a close texture on being cut. The shape of the potato should be such as suits the market for which it is grown."

With potatoes, whenever fertilization takes place, seed-balls are produced on the plants. It is possible to produce new varieties of potatoes from the seeds of them, but the chances for producing a superior variety are not so good as when artificial cross-fertilization is practised.

Mixing of Varieties.—Will varieties of potatoes mix in the field? This question is often asked and always answered in the negative, the reason being that the potato is propagated by means of tubers (asexually) and not by seed. It is impossible for any crossing to take place except when potatoes are produced from seed. Environmental influences may bring about changes in the plant which causes a breaking-up of the type. Such changes are called "sports" or "mutations." This occurs also among other species of plants and animals.

CLASSIFICATION OF VARIETIES.

At a time when there are many hundreds of varieties of potatoes on the market, some old varieties under new names, growers would do well to make themselves acquainted with some kind of group classification of varieties.

In looking over varieties of potatoes at fairs and other exhibitions, one repeatedly finds varieties of potatoes wrongly named. A mistake such as this, although a bad one, is undoubtedly difficult to avoid. However, when a red variety is called a Green Mountain, or a flat-shoped potato is called an Irish Cobbler—and this is often the case—then the mistake is a serious one.

Varieties of potatoes may be classed according to colour and shape of tubers, maturity, colour of sprouts, depth of eyes, and colour of flowers. The most perfect classification is one that will consider all these factors. Many classifications have been given from time to time, but none have filled a long-felt want so well, both in Canada and the United States, as Professor Wm. Stuart's classification. His classification of the main groups is based on the colour and shape of tubers; and the sections, on colour, shape, and size of tubers, depth of eyes, colour of sprouts, and the colour of the flowers.

The writer firmly believes that if growers would at least try to place their varieties in the right group it would be a great help to themselves and to the potato industry in general. The classification of varieties into groups is undoubtedly the first step towards an intelligent study of varieties.

The classification which is given in this bulletin is the one drawn up by Professor Wm. Stuart, Potato Expert, United States Department of Agriculture. The main groups, together with a short description of the tubers, sprouts, and flowers, are given, also the varieties belonging to each group. Many popular varieties grown in Canada may have been omitted, but with such a classification as this to serve as a guide it should be possible to take any variety and place it in its right group. The practical advantage of this classification will be readily seen on a close study of the following groups:—

GROUP 1—COBBLER.

Tubers: Roundish; skin, creamy white.

Sprout: Base, leaf-scales, and tips, slightly or distinctly tinged with reddish-violet or magenta; in many cases the colour is absent.

Flowers: Light rose-purple; under intense heat may be almost white.

The following more common varieties belong to the Cobbler Group: Early Eureka, Extra Early Eureka, Irish Cobbler, Hustler, Isle of Jersey, and Early Record.

GROUP 2—TRIUMPH.

Tubers: Roundish; skin, creamy white, with more or less numerous splashes of red or carmine or solid red; maturity very early.

Sprouts: Base, leaf-scales, and tips, more or less deeply suffused with reddish-violet.

Flowers: Very light rose-purple.

The following varieties seem to belong to the Triumph Group: Bliss Triumph, White Triumph, Quick Lunch, Norton Beauty, and Stray Beauty.

GROUP 3—EARLY MICHIGAN.

Tubers: Oblong or elongate, flattened; skin, white or creamy white, occasionally suffused with pink around bud-eye cluster in Early Albino.

Sprouts: Base, light rose-purple; tips, creamy white or light rose-purple.

Flowers: White.

The following varieties are classed in the Early Michigan Group: Early Albino, Early Michigan, and Early Puritan.

GROUP 4—ROSE GROUP.

Tubers: Roundish, oblong to elongate, flattened, or spindle-shaped, flattened; skin, flesh-coloured or pink or (in the case of the White Rose) white.

Sprouts: Base and internodes, creamy white to deep rose-lilac; leaf-scales and tips, cream to rose-lilac.

Flowers: White in Sections 1 and 2; rose-lilac in Section 3.

The following varieties are classed in Section 1: Thorburn, Irish Cups, Canadian Beauty, Manitoba Wonder, Bermuda, Early Goldfinder, Clark's No. 1, Early Durham, Early Fortune, Early Maine, Early Norther, Early Rose, Early Roser, Early Thoroughbred, Early Vermont, Early Walters, Extra Early Fillbasket, Extra Early Vermont, Extra Early White Rose, Houlton Rose, Late Rose, Northern Beauty, Rochester Rose, and Somer's Extra Early.

Section 2: Manistee (Early and Improved) and Spaulding No. 4.

Section 3: Crine's Lightning, Extra Early Red Rose, Jones' Pink-eyed Seedling, Lee's Favourite, Livingston, New Ideal, New Scotch Rose, Old Early Rose, and Seneca Beauty.

GROUP 5—EARLY OHIO GROUP.

Tubers: Round, oblong, or ovoid; skin, flesh-coloured or light pink, with numerous small, raised russet-spots.

Sprouts: Base, leaf-scales, and tips, more or less deeply suffused with carmine-lilac to violet-lilac or magenta.

Flowers: White.

Varieties: Early Ohio, Early Market, Prize Early Dakota, Ratekin's Red River Special, Early Acme, Early Six Weeks, Late Ohio, and White Ohio.

GROUP 6—HEBRON GROUP.

Tubers: Elongated, somewhat flattened, sometimes spindle-shaped; skin, creamy white, more or less clouded with flesh colour or light pink.

Sprouts: Base, creamy white to light lilac; leaf-scales and tips, pure mauve to magenta, but colour sometimes absent.

Flowers: White.

Varieties: Columbus, Crown Jewel, Early Beauty of Hebron, Country Gentleman, Early Bovee, Gem of Aroostock, Harbinger, Improved Beauty of Hebron,

Burpee's Extra Early, Junior Pride, Late Beauty of Hebron, Milwaukee, New Queen, Quick Crop, Star of the East, Vigorora, and White Elephant.

GROUP 7—BURBANK GROUP.

Tubers: Long cylindrical to somewhat flattened, inclined to be slightly spindle-shaped; skin, white to light creamy white, smooth and glistening, or deep russet in the case of Section 2.

Sprouts: Base, creamy white or faintly tinged with magenta; leaf-scales and tips, usually lightly tinged with magenta.

Flowers: White.

Varieties: Section 1—Burbank or Burbank's Seedling, Money Maker, Pride of Multnomah, White Beauty, and White Chief. Section 2—California Russet, Cambridge Russet, Olds Golden Russet, New Wonderful, Russet Burbank, and Scabproof.

GROUP 8—GREEN MOUNTAIN.

Tubers: Moderately to distinctly oblong, usually broad, flattened; skin, a dull creamy or light russet colour, frequently having russet-brown splashes towards the seed-end.

Sprouts: Section 1—Base, leaf-scales, and tips, creamy white. Section 2—Base, usually white, occasionally tinged with magenta; leaf-scales and tips, tinged with lilac to magenta.

Flowers: White.

The following varieties are believed to belong to the white-sprout division, Section 1: Bethel Beauty, Blightless Wonder, Carmen No. 1, Clyde, Delaware, Empire State, Farmer, Freeman, Gold Coin, Green Mountain, Gurney's White Howest, Keystone, Late Blightless, Long Island Wonder, Norcross, Pride, Snow, State of Maine, Uncle Sam, and White Mountain.

GROUP 9—RURAL.

Tubers: Broadly round, flattened, to short oblong, or distinctly oblong, flattened; skin, creamy white or deep russet in the case of Section 2.

Sprouts: Base, dull white; leaf-scales and tips, violet-purple to pansy-violet.

Flowers: Central portion of corolla, deep violet, with the purple growing lighter toward the outer portion; five points of corolla, white or nearly so.

Varieties: Section 1—Arcadia, Carmen No. 3, Great Divide, Jackson White, Late Victor, Lily White, Million Dollar, Noxall, Ohio Wonder, Peerless, Prosperity, Rhind's Hybrid, Rural New Yorker No. 2, Sir Walter Raleigh, White Grant, and White Swan. Section 2—Late Petoskey, Russet, and Roxbury.

GROUP 10—PEARL.

Tubers: Round, flattened, to heart-shaped, flattened, usually heavily shouldered; skin, dull white, dull russet, or brownish-white in Section 1, or a deep bluish-purple in Section 2.

Sprouts: Section 1—Base, leaf-scales, and tips, usually faintly tinged with lilac. Section 2—Base, leaf-scales, and tips, vinous mauve.

Flowers: White.

Varieties: Section 1—Pearl and People's. Section 2—Blue Victor.

GROUP 11—PEACHBLOW.

Tubers: Round to round, flattened, or round oblong; skin, creamy white, splashed with crimson or solid pink; eyes, usually bright carmine. Includes some early-maturing varieties.

Sprouts: Base, leaf-scales, and tips, more or less suffused with reddish-violet.

Flowers: Purple.

Varieties: Dykeman, Early Peachblow, Extra Early Peachblow, Improved Peachblow, Jersey Peachblow, McCormick, New Improved Peachblow, New White Peachblow, Nott's Peachblow, Perfect Peachblow, and White Peachblow.

A DESCRIPTION OF SOME OF THE MORE IMPORTANT VARIETIES.

(Illustration on page 50.)

Early Epicure.—(Fig. 38.) A variety of British origin. Season, early. Plant, a strong grower; flowers, white; tubers, roundish; colour, pale pink; eyes, many, deep. This variety has so far not proved itself to be a heavy yielder, and for this reason was discarded by the Dominion Experimental Farms.

(Illustration on page 50.)

Early St. George.—(Fig. 39.) A variety of unknown origin. Season, early. This potato averages medium in size, elongate-oval in shape, white in colour, and white sprouts. This variety has generally not proved to be a heavy yielder.

(Illustration on page 51.)

Irish Cobbler.—(Fig. 40.) Origin unknown. Claimed by some seedsmen to have been first grown by an Irish shoemaker of Marblehead, Mass. This variety is medium early maturing and an excellent yielder of good quality. The flowers are light rose-purple, under intense heat white. Tubers, nearly round and large; eyes, deep and numerous; skin, creamy white. On account of the large crops that this variety produces it is grown very extensively in some parts of Canada and in the United States. The Extra Early Eureka variety is almost identical with this, and the two are practically indistinguishable.

(Illustration on page 51.)

Early Rose.—(Fig. 41.) Originated by Albert Bresee, Hubbardton, Vermont, in 1861; claimed to be a seedling of Garnet Chile. Introduced in a limited way in 1867 by D. S. Heffron, of Utica, N.Y.; introduced to the public by B. K. Bliss & Sons in 1868. Season, medium early. Tubers, oblong to long, tapering at ends, pink in colour, with eyes of medium depth and strong. This variety is usually inferior in productiveness. The flowers are white in colour.

(Illustration on page 52.)

Early Surprise.—(Fig. 42.) Originated by S. W. P. Jerrard, Caribou, Ne., in 1900. Claimed to be a seedling; parentage not given. Introduced by the Jerrard Company in 1902 in a limited way. This is a medium early variety. The tubers vary in shape from nearly round to elongate; eyes, medium depth; skin, flesh white. The variety is credited with being of good quality, although not very productive.

(Illustration on page 52.)

Green Mountain.—(Fig. 43.) Originated by O. H. Alexander, Charlotte, Vermont, in 1878; said to be a seedling from a cross between Excelsior and Dunmore. Introduced by J. A. Everitt & Co. in 1885. Variety, late in maturing; not extensively grown in this Province, but becoming more popular. In Ontario and Maritime Provinces and in parts of the United States this variety is grown extensively. It has white flowers; the tubers are oblong in shape, inclined to be blocky or flattened at the ends. A good yielder of fair table quality.

Several varieties almost identical with this are Delaware, Carmen No. 1, Gold Coin, and Wee McGregor.

(Illustration on page 53.)

Gold Coin.—(Fig. 44.) Originated by Gideon T. Safford, North Bennington, Vt. Introduced by W. A. Burpee in 1903. This variety also belongs to the Green Mountain Group and has therefore white flowers. Tubers, slightly oblong, rather broad, quite thick, and ends somewhat rounded; eyes, small; skin, thin, smooth, glossy, and of a light-golden tint. This variety has proved itself a good yielder of fair quality.

(Illustration on page 53.)

Eureka.—(Fig. 45.) Origin unknown. Introduced by Frank Ford & Sons in 1891 as a new variety. Season, medium. A good yielder. Tubers, large, long, oval, or nearly round; eyes, numerous, shallow; skin, white, much russeted.

(Illustration on page 54.)

Jones' White.—(Fig. 46.) Introduced from Ireland in 1913 by P. W. Anketell Jones, of Chemainus, B.C. A good yielder of excellent quality. The flowers are purple and the tubers oval and short, with a russety skin and shallow eyes. A late-maturing variety. It looks as though this variety will become popular, since it possesses some very desirable features.

(Illustration on page 54.)

Netted Gem.—(Fig. 47.) Origin unknown. A late-maturing but popular variety in this Province. Skin, russet-brown, finely netted; eyes, shallow; tubers, long to oval and elongated. A good yielder of excellent quality. This variety is more adapted to the irrigated district.

(Illustration on page 55.)

Up-to-date.—(Fig. 48.) A variety of British origin. Season, late; plant, a strong grower; flowers, violet; tubers, oval; skin, yellow; eyes, few; shallow to medium in depth. Not extensively grown in British Columbia, but very favourable results have been reported, covering the quality and yield, by many growers. It will probably become a very popular variety.

(Illustration on page 55.)

Empire State.—(Fig. 49.) Originated in 1881 by E. C. Cory, Hebron, N.Y., from seed of White Elephant and introduced by W. A. Burpee in 1885; variety late in maturing. A popular and extensively grown variety in some parts of Canada. Tubers, long; skin, white and smooth; eyes, medium depth. A good yielder of good quality.

(Illustration on page 56.)

Jersey Royal.—(Fig. 50.) Imported from the Isle of Jersey in 1916, and therefore a comparatively new variety in this Province. Plant, a strong grower; season, medium early. The tubers are long and white. This variety has so far proved itself to be a good yielder of excellent quality, and is therefore a very promising variety.

(Illustration on page 56.)

Sir Walter Raleigh.—(Fig. 51.) Originated by E. S. Carmen. Claimed to be a seedling of the Rural New Yorker No. 2. Introduced by Peter Henderson in 1897. Season, late; plant, a strong grower; tubers, roundish oval; skin, creamy white; eyes, scattered and medium to shallow in depth. A fair yielder of good quality. Grown very extensively on parts of Vancouver Island.

(Illustration on page 57.)

Burbank.—(Fig. 52.) Originated by Luther Burbank in 1873 and is claimed to be a seedling of Early Rose. Introduced by J. H. Gregory in 1876. Season, medium late; plant, a strong grower; tubers, long, cylindrical; skin, dull white; eyes, shallow to medium. It thrives well on new rich soils well supplied with humus. The sprouts are green with pinkish base; stems, light green; flowers, white. This variety is adapted to moist or irrigated districts. It is extensively grown in British Columbia, especially in the Ashcroft District.

Carmen No. 1.—Originated by E. S. Carmen in 1889; claimed to be a seedling of seedlings raised through several generations. Introduced by J. M. Thorburn & Co. in 1894.

This variety belongs to the Green Mountain Group and has therefore white flowers. The tubers are oblong, inclined to round-oval, rather flattened; the eyes are few and shallow; flesh, white. A potato of good quality and a heavy yielder.

Fig. 38. Early Epicure (original).

Fig. 39. Early St. George (original).

Fig. 40. Irish Cobbler (original). Note that eyes are deeper than cut illustrates.

Fig. 41. Early Rose (original).

Fig. 42. Early Surprise (original). Note the variation in type.

Fig. 43. Green Mountain (original).

Fig. 44. Gold Coin (original).

Fig. 45. Eureka (original).

Fig. 46. Jones' White (original).

Fig. 47. Netted Gem (original).

Fig. 48. Up-to-date (original).

Fig. 49. Empire State (original).

Fig. 50. Jersey Royal (original).

Fig. 51. Sir Walter Raleigh (original).

Fig. 52. Burbank (after Macoun).

INSECT PESTS.

Colorado Potato-beetle.—(Fig. 53.) The potato-growers in British Columbia are fortunate in not having to fight the Colorado beetle, or "potato-bug," as it is commonly known in the East. This pest, however, is established in the States of Idaho and Washington and last year (1919) crossed the Boundary. The infestation was in the potato-patch at Newgate, in East Kootenay. Fortunately the pest was noticed in time and, we have reason to believe, was completely exterminated. It will mean a good deal of increased expense, especially to the growers in the Dry Belt, where spraying is at present not necessary, if this pest should become generally distributed

Fig. 53. Colorado potato-beetle (after Bethune).

over the Province. It is very important, therefore, that any outbreaks which may occur be completely cleaned up in the early stages. For this reason any insect suspected of being this pest should be sent at once to some officer of the Department of Agriculture for examination. In order to help identification by those not familiar with it a brief description is here given. The insect is most likely to be met with in the larval or grub stage.

The adult beetle is about ½ inch long, rather broad in proportion to its length, orange in colour, with ten black stripes down its back. The eggs are yellow and laid in patches on the under-side of the leaves. The larvæ are of a brick-red colour and of a peculiar and characteristic hump-back form. They are a little over ½ inch long when full-grown. They feed with great voracity for about three weeks and pupate in the soil.

Blister-beetle.—In the Dry Belt a certain amount of damage is done by a slender, grey-black beetle (blister-beetle) which eats the leaves. No doubt this insect can be destroyed by spraying with arsenicals such as arsenate of lead or Paris green. It is doubtful, however, whether this is advisable. Although the adult insect does some injury, its larvæ feed on the eggs of the locust (grasshoppers), and, therefore, on the whole, it is probably a useful insect.

Wireworms.—These pests are more or less prevalent everywhere and are very hard to exterminate. They are the larvæ of "click-beetles" or "skipjacks" and are liable to be found in numbers in land that has previously been in meadow, and

they seem to prefer strong land and moist situations. Badly infested land may sometimes be cleared of them by deep fall ploughing followed by plenty of cultivation and the next year by summer fallow. In this case the land should be kept perfectly clear of weeds in order to starve the wireworms out and to prevent the adult beetles from laying their eggs there.

Another method which is practised largely by Japanese growers is to plant balls of rice-meal between the rows to act as traps for the worms. The rice-meal is first browned over a fire and is then made up with a little water into balls about the size of an egg. These are planted at intervals of about 2 or 3 feet and dug up at the end of a week or ten days and the worms destroyed and the balls replaced. This entails much labour, but provided that it is done in early spring before the crop is planted it is very efficient in clearing the land of wireworms. In experiments conducted at Kelowna an average of twenty wireworms per ball was taken, but occasionally these numbers are greatly exceeded. It would be most feasible to give the infested balls to hogs or poultry and replace with fresh.

Fig. 54. Larva of June beetle or white grub (photo by W. Downes).

Fig. 55. Adult June bettle (photo by W. Downes).

The June Bug.—This is a large white grub, 2 inches in length when full-grown (Fig. 55), which sometimes attacks potato-crops, doing considerable damage. It is the larva of a large brown beetle (Fig. 54) marked with ten white stripes on the wing-cases and is easily recognized. Normally the grubs live on grass-roots, but when potatoes are planted on sod land containing these grubs they will attack the potatoes or almost any other crop with which the land is planted. Whenever plants are seen to be wilted and the cause is found to be the attack of the grubs they should be searched for and destroyed. When whole fields are affected the only remedy is to plough and turn in hogs and poultry.

Flea-beetles.—Small, hopping black beetles frequently damage potato-fields to a considerable extent. They attack the foliage, eating little round holes in the leaves, and when in numbers the damage they do is very great.

Control: Spray with Bordeaux mixture, which acts as a repellent, or with arsenate of lead, 4 lb. to 40 gallons of water.

Cutworms.—When cutworms are present in numbers they sometimes destroy the crop by eating off the young leaves as fast as they appear above the ground. The best remedy is to scatter between the rows the bran and Paris green mash which is the standard remedy for these pests. It is made as follows: Take 20 lb. of bran and stir into it while dry ½ lb. of Paris green. Care should be taken that these are thoroughly mixed, as upon this depends the efficiency of the bait. Dissolve 1 quart of molasses in from 2 to 3 gallons of water and mix this with the bran, making a stiff mash. The mixture should be scattered in the evening and renewed until the cutworms are destroyed.

POTATO-DISEASES.

Diseases cause enormous losses to the potato-crop each year. In British Columbia the diseases are not so widespread as they are in other parts of Canada; therefore it is of all the more importance that growers make themselves more familiar with the various diseases which attack the potato-crop and adopt the methods advocated for their control.

Fig. 56. An illustration to show where late blight started in an unsprayed plot. Note the dead stalks of the blighted plants (original).

Fig. 57. Sprayed and unsprayed potatoes. The unsprayed plants are dead, while the sprayed are comparatively vigorous.

Most potato-diseases are caused by fungi; some, however, are caused by bacteria, others by the effect of the weather, and others by unknown agents.

Fungi, being unable to manufacture their own food, obtain their nourishment from decaying animal or vegetable remains or from living plants and animals.

These fungi, which derive their nourishment from living plants, set up an irritation in the plant which gives rise to fungous diseases.

For convenience the various potato-diseases may be included under three headings: (1) Diseases of the "vines" and tubers; (2) diseases of the vines only; (3) diseases of the tubers only.

DISEASES OF THE "VINES" AND TUBERS.

LATE BLIGHT *(Phytophthora infestans)* (Figs. 56, 57).

This is the most destructive disease of the Lower Fraser Valley, but does not seem to be of much consequence elsewhere. It is absent from the Dry Belt. The disease shows first on the leaves, usually not being noticed until late summer or fall. Brown, water-soaked spots appear, which gradually extend (Fig. 58). In warm, moist weather the disease may spread so rapidly that in two or three days an entire field looks as if hit by severe frost. A characteristic unpleasant smell accompanies this blighting of the vines. The premature killing of the tops checks the development of the tubers, thus reducing the yield. More serious still is the danger of the tuber becoming infected from the diseased tops. Such tubers may rot in the soil

Fig. 58. Late blight as it appears on leaf (original).

Fig. 59. Late blight as seen in tuber (original).

before being dug or in storage. Lightly infected tubers, however, often keep perfectly well, and it is such tubers used as seed which start the disease each season. On the tubers the disease shows as leaden-coloured, often sunken, spots (Fig. 59).

On cutting, a brown discoloration will be found in the flesh corresponding to these spots and extending perhaps for a considerable distance within. Infection of the tuber takes place from the disease in the "vines."

Control.—Spraying with Bordeaux mixture prevents the disease from developing in the foliage, and hence protects the tubers also. As the disease rarely appears until the middle of August, it was thought that it would be satisfactory to begin spraying about that time. Experimental work, however, has shown the desirability of spraying early in the season. In the first place if spraying is deferred until the vines are full-grown it is very difficult to cover the lower leaves and the centre of the plant; and, secondly, early blight may have seriously damaged the crop if conditions have been favourable to it. The first spraying should be Bordeaux mixture 6-6-40; later spraying may be 4-4-40 (*see* article on spray mixtures). At least three sprayings should be given, but in wet seasons this may not be enough, and it may be necessary to spray at intervals of eight to ten days.

It has been shown repeatedly that, even if no blight appears, spraying pays for itself in increased yield, the foliage being stimulated to greater and more extended activity.

Lime-sulphur, so much used for fruit-trees, is unsatisfactory for potatoes.

Early varieties usually escape the disease. Weeds hold moisture around the plants and help to bring about infection. So also does low-lying, undrained, damp land. If the disease has assumed serious proportions in the tops, a certain amount of tuber-infection is inevitable. This may, however, be much increased by careless handling. The proper way of dealing with a blighted crop depends on circumstances. If the market permits of immediate disposal, the safest plan may be to dig and ship at once. Ordinarily, however, it is best to let the disease die out in the tops before

Fig. 60. *Rhizoctonia* on tuber (after Howitt).

digging, otherwise increased infection of the tubers may result from the disease-spores in the dead tops. After a few days, especially if the weather becomes fine and dry, this danger is lessened. The worst thing possible is to pile the tubers on the field covered with tops newly killed by the disease. This can bring about 100 per cent. infection. It is not advisable to store a diseased crop over winter. Loss is almost certain to occur unless storage conditions are exceptionally good. If storage is to be tried, every care should be taken to remove all mechanically damaged and obviously diseased tubers, and good ventilation should be provided.

Fig. 61. *Rhizoctonia* as it affects the plants (after Orton). Note the aerial tubers due to lesions at the base of the stem.

BLACK SCURF (*Rhizoctonia*).

Tubers are often seen with what appear to be small lumps of hard dirt adhering to them. It is found, however, that these are not readily rubbed off, and if moistened they turn black. They vary in size from less than a pin-head to almost that of a 5-cent piece. Frequently the layer is so thin that it merely gives a black mottling to the skin. These black masses (Fig. 60) are composed of the resting mycelium of a fungus (*Rhizoctonia*), and in this stage do no injury. If they are removed—e.g., with the finger-nail—the underlying skin of the tuber is found to be perfectly sound. If planted with the tuber, however, the fungus develops and may produce considerable injury in the growing crop by attacking the base of the stem near the level of the ground, forming dead brown spots which may completely girdle it. According to the severity of the attack, the vine either dies outright or the supply of food substances to develop tubers is prevented from reaching the underground parts from the leaves. In such a case the accumulation of food sub-

stances causes the production of small potatoes elsewhere. They may cluster round the base of the stem or be found above ground in the axils of the leaves; i.e., between the leaves and the stem (Fig. 61). Another stage of the fungus (*Corticum*) often appears on the potato-stems as a grey mould in the latter part of the season.

Control is difficult, since it is almost impossible to get a disinfectant strong enough to kill the fungus-masses right through without injuring the potato. Tubers

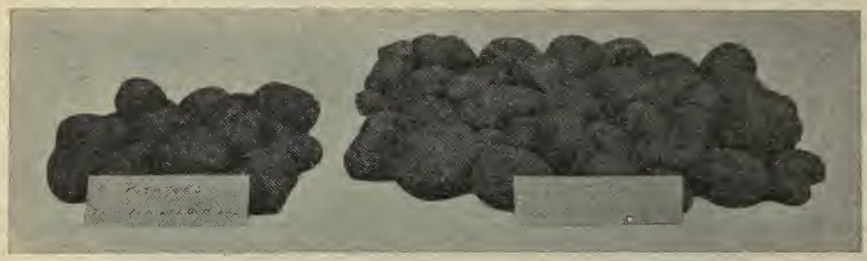

Fig. 62. Potatoes to the left the product of ten wilted hills; those on the right the product of ten normal hills (after Orton).

with large *Rhizoctonia* masses should be discarded for seed and the remainder disinfected. Corrosive sublimate is effective as a disinfectant for *Rhizoctonia*, while formaldehyde is not. Potatoes that are vigorous and well cared for often seem to be able to carry a surprising amount of infection without much apparent injury.

FUSARIUM WILTS AND ROTS (Fig. 62).

These are due to fungi of the genus *Fusarium*, which affect both the growing plant and the tubers. The commonest form of the disease is the so-called "brown-ring" (Fig. 63), which shows as a ring of brown dots in the flesh when a thin

Fig. 63. Stem-end rot or brown-ring (original).

slice is taken off the stem-end of the tuber. On cutting deeper into the potato the ring becomes fainter and finally disappears. Often it is only visible just below the point of attachment of the stolon. The brown discoloration is due to invasion of the sap-vessels by the mycelium of the fungus. Such tubers, if not too badly infected and kept under good storage conditions, may keep quite well until spring. Many, however, undergo a process of dry-rot. Under moist conditions a "soft" rot occurs, which is often helped by various bacteria. In certain seasons where fall

rains have been heavy, with rotting of the tubers in the ground, it has frequently been found that hills with "brown-ring" tubers were especially liable to rot. The so-called "jelly end-rot" or "jelly ends," which occasionally occurs in Netted Gem potatoes, is also due to one of these *Fusaria*.

If tubers affected with "brown-ring" are planted, or if healthy tubers are planted on soil infected with the disease, the "wilt" form appears in the growing plants. Such plants show a pale colour, with limp drooping leaves. If the stem is cut across, the vascular bundles, instead of being white, are brown. If tubers are present they will probably have the "brown-ring" also, and in this way the disease is propagated. Infected plants may die early, but in many cases they live long enough to produce a crop of infected tubers.

Control is difficult. Rotation is important, the worst infected areas being those on which potatoes have been grown in close succession for a number of years. Seed-selection is also important, and some very striking results have been obtained where care has been taken. Every seed-tuber should have a thin slice cut off the stem-end and those showing the brown ring discarded. This may be done before disinfecting. If a sample shows 10 per cent. or more of "brown-ring," it is best to discard the whole lot unless no better can be procured. Where a seed-plot is grown, all potatoes showing wilt should be carefully "rogued" out before digging-time.

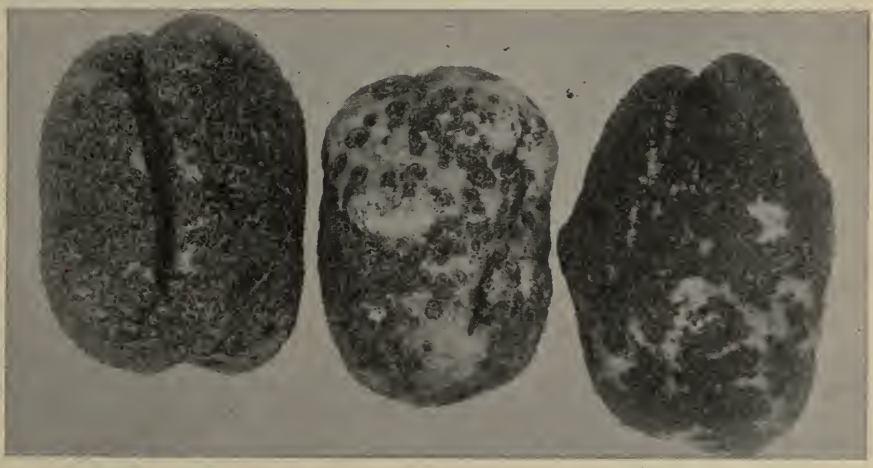

Fig. 64. Common scab (original).

PARASITIC DISEASES OF THE TUBER.

COMMON SCAB (*Actinomyces scabies*).

This affects the tubers only and is found wherever potatoes are grown. It appears as round or oval, raised corky spots on the surface, or simply as a thick, irregular roughening of the skin (Fig. 64). It may only form occasional small spots on the tubers, or it may almost cover the entire surface. Early infestation or the additional work of insects sometimes results in pits or cavities, which not only blemish and make extra labour in preparing potatoes for the table, but also expose the interior of the tuber to various rot-fungi. While scabby potatoes, if not too severely affected, are not really injured for human food, they often have an earthy taste, and there is more waste in preparing them for the table. In any case the prejudice on the part of the consumer against scabby potatoes affects the market value, and it is therefore in the interests of the grower to have as little scab as possible.

Control.—Scab is due to a bacterial organism present in the soil or on the seed planted. In the former case it may be necessary to discontinue potato-growing on such land for a time. Seed-disinfection before cutting will prevent the latter.

While the disease cannot exist without the primary cause—the "germ"—there are certain other factors which influence the severity of the disease. Hence:—

(1.) Do not use alkaline fertilizer—e.g., wood-ashes, lime, marl, etc.—with, or just before, the potato-crop.

(2.) Do not plant the seed in contact with manure.

(3.) Avoid heavy, wet, undrained soil.

POWDERY SCAB (*Spongospora subterranea*).

This is also a tuber-disease only (Fig. 65). It is found in many parts of the Coast and Island sections, but absent from the Interior. It resembles common scab, but the spots are more even in shape, smaller, retain their individual outlines even when very numerous and close together, are covered when young with the smooth skin, and when mature are hollow and filled with brownish or greenish powder, whence the name. The spots have also a tendency to be arranged in belts around the tuber. This is a somewhat more serious disease than common scab, as when severe it may go deeper into the substance of the potato and is more liable to cause "wilting" in storage. All cases seen in this Province, however, belong to the milder, superficial type.

Fig. 65. Powdery scab (after Gussow). Fig. 66. Potato-canker (after Gussow).

Control.—Use sound seed, disinfect it, and avoid favouring causes as given above for common scab. Where it has gained a footing, rotation and the disinfection of bins, cellars, and implements are necessary. Manure from stock which have been fed with uncooked infected potatoes should not be used for the potato-crop.

SILVER SCURF (*Spondylocladium atrovirens*).

This is due to a fungus which lives in the skin of the tuber. The attacked skin becomes more or less silvery and glistening, usually in spots, which, however, may run together until a large area of the potato is affected. The substance of the tuber is not affected, and the chief injury appears to be in increased wilting in storage.

Hand-selected seed free from the disease, disinfection to kill any loose spores, and rotation are the only measures known against it.

POTATO WART OR CANKER (*Chrysophlyctis endibiotica*) (Fig. 66).

This disease is not present in this Province or in any other Province of the Dominion at the present time. However, on account of its very *serious* nature, it is of vital importance that potato-growers become thoroughly familiar with the symptoms of this disease.

Potato-wart has been gradually spreading in Northern Europe for many years. It was discovered in the United States in 1918 in the State of Pennsylvania. Much attention was at once given to a publicity and educational campaign, with the result that the disease has been prevented from spreading.

As the name indicates, the disease is characterized by warty outgrowths on the underground portions of the plant. Tubers showing the early stages of the disease have some of the eyes slightly protruding and composed of simple or compound

groups of small nodules brown in colour. These gradually increase in size, become darker, and finally black in colour.

The disease does not kill the potato-plant and seldom interferes seriously with the growth of the potato-vines. The best time to detect the disease is during digging.

Any suspicious samples should be forwarded *promptly* to Mr. J. W. Eastham, Provincial Plant Pathologist, Court-house, Vancouver, B.C., or to the Dominion Botanist, Central Experimental Farm, Ottawa, Ontario.

Fig. 67. Hollow-heart or hollow-potato (after Gussow).

Fig. 68. Internal brown-streak or "net necrosis" (after Gussow).

SOFT-ROTS.

Soft-rots, which break down the substance of the potato to a soft evil-smelling mass, are generally the work of bacteria which obtain entrance through mechanical injuries or follow some of the above-mentioned fungi. They develop very rapidly under warm, moist conditions and furnish an additional reason for selecting only sound tubers for storage.

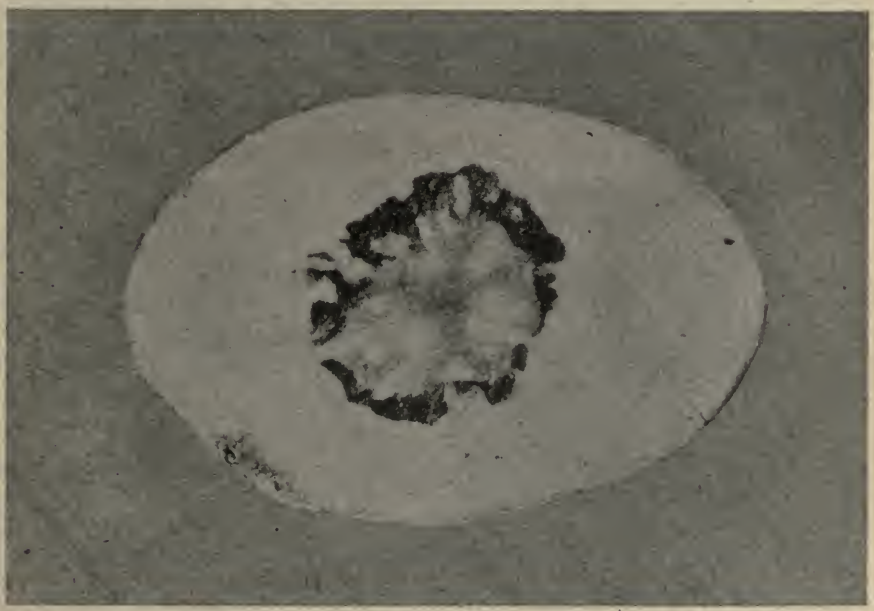

Fig. 69. Black-heart (after Potato Magazine).

NON-PARASITIC DISEASES OF THE TUBER.

There are certain troubles not apparently caused by parasites, but rather by physical conditions, such as frost, soil conditions, etc.

"Hollow-heart" or "hollow-potato" (Fig. 67) is chiefly found in oversized potatoes and is due to too rapid growth.

"Internal brown-streak" or "net necrosis" (Fig. 68) much resembles "wilt," but the brown dots are not arranged in so regular a ring, nor confined so much to the stem-end.

"Internal brown-spot" appears as larger brown or blackish spots, irregular in shape, scattered through the tuber.

Both these diseases appear to be due to soil conditions, possibly to overheating of the soil.

"Black-heart" (Fig. 69), a black rubbery condition of the centre of the tuber, is due to lack of ventilation in storage, especially if accompanied by warmth.

"Frost-injury" (Fig. 70). Tubers sometimes will become so chilled as to develop internally a fine network of black threads, usually in the outer portions of the flesh.

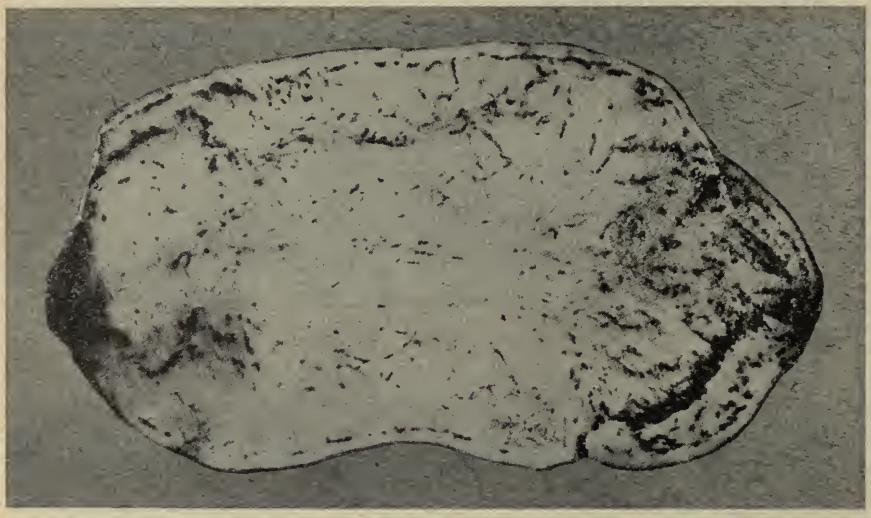

Fig. 70. Frost-injury (after Potato Magazine).

DISEASES OF THE "VINES."

LEAF-ROLL (Fig. 71).

This is one of the newer diseases of potatoes, or perhaps better stated as a disease which has been present for some time in certain parts of Canada, but which only in recent years has begun to attract attention. At present leaf-roll is very little in evidence in this Province; however, the writer found a few plants during the summer 1920. In some parts of Canada, such as in Ontario, leaf-roll was very much in evidence until certified seed was started.

Leaf-roll was first recognized in Europe in 1905, in the United States in 1911, and in Canada in 1914.

Symptoms.—The plant is considerably dwarfed in size, with foliage slightly discoloured, at times of a lighter green and at others of a yellowish tint. A rolling of the upper leaves may or may not be in evidence; however, the diagnosis of leaf-roll is most accurately made by an examination of the lower leaves. Here we have an upward rolling of the leaves; one or more leaflets may be affected. These symptoms are noticeable at an early stage of growth. As the plant matures the tips of rolled leaves turn brown and later on die, and are further characterized by

Fig. 71. A typical leaf-roll plant (photo by P. Murphy).

their harsh, brittle texture. Plants of such varieties as Green Mountain assume a low-headed, bushy appearance when infected with leaf-roll, while those of the Irish Cobbler type assume a stiff, upright appearance. Another good diagnostic character is the low yield and close attachment of the potatoes in clusters to the stem. There is no sign of disease on or within the tubers, and for this reason potatoes from leaf-roll plants will likely be planted by one who is inexperienced at identifying a leaf-roll plant during the growing season.

Leaf-roll may be first detected when the plants are from 5 to 8 weeks old, and if there are no evidences of leaf-roll when the plants are 9 weeks old the disease will probably not develop later.

No casual organism has yet been isolated in connection with this disease, and

Fig. 72. Plant on the left affected with leaf-roll; that on the right is healthy (photo by P. Murphy).

although many theories have been advanced regarding the cause, none of these theories have been accepted as yet.

Economic Importance.—Leaf-roll (Fig. 72) is a serious disease because it reduces the yield to about one-third of the normal, and also greatly reduces the percentage of marketable tubers (Fig. 73).

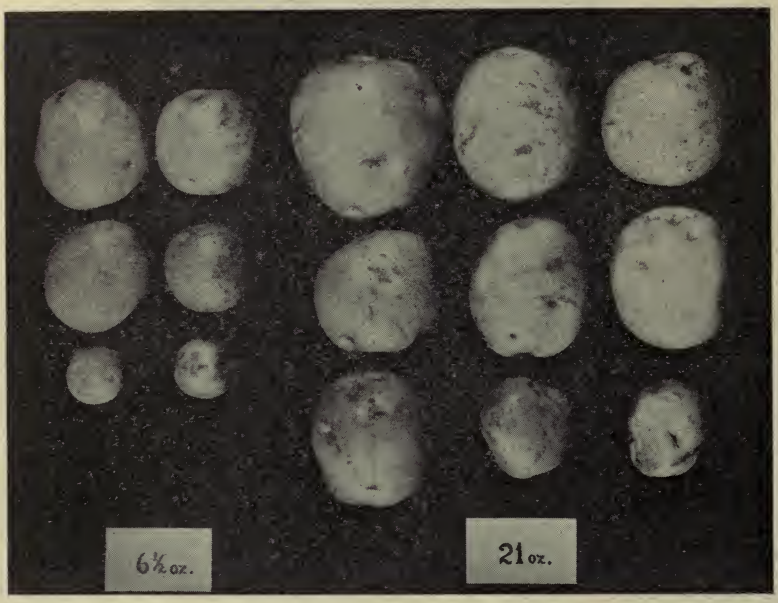

Fig. 73. Potatoes on the left the product of the leaf-roll plant in Fig. 72; those on the right the product of the healthy plant (photo by P. Murphy).

Control.—When a crop is bady infected with leaf-roll it is better to secure seed from districts free from the disease. Spraying and treatment of the potatoes is of no use.

MOSAIC (Fig. 74).

This disease has for some years now been attracting the attention of plant pathologists in Europe and America. This disease is also very prevalent in some parts of Canada, but little in evidence in British Columbia.

Symptoms.—Plants affected with mosaic bear an abnormal condition of the foliage, as characterized by the spotted or mottled appearance of the leaves, portions of which are lighter green in colour; the discoloration is not very clear in sunlight, but in shade it is very marked. The leaves may be puckered, particularly when the disease is in the advanced stage, and the lower leaves sometimes fall off, leaving the stem bare. No other marks will be found on any parts of the affected plants or on the tubers. The tubers are normal looking and sound and their keeping or eating qualities are not impaired. This disease can be recognized most easily in July, although it may be observed by careful examination at any time during the growth of the plant. Like leaf-roll, it is inadvisable to leave the examination for mosaic until late in the season, as other diseases may be attacking the plant or the plant dying off.

The yield of potatoes is not reduced to the same extent as in leaf-roll, seldom exceeding 50 per cent. of the crop.

The cause of this disease, like leaf-roll, is unknown.

Control.—The best means of control up to the present time is that of selection of seed from districts where mosaic does not occur.

Fig. 74. Plant on the left typical Mosaic; the one on the right healthy (original).

EARLY BLIGHT (*Alternaria solani*).

This is so called because it usually first appears earlier in the season than late blight. It appears as dark-brown spots on the leaves, which, typically, have a very characteristic zoned or target-like appearance. The tips and margins of the leaf may also be affected. Tubers are not directly attacked, but if the leaves are seriously injured their development is checked. Spraying with Bordeaux is effective against early blight, but must be done early, beginning when the plants are 4 inches high.

Fig. 75. Skin-spot disease. Cause not yet determined (original).

TIP-BURN.

The tips and edges of the leaves turn brown, curl up, and become crisp and brittle, due to intense sunlight, especially after dull, cloudy weather. This is often associated with early blight and is controlled by the same means; the covering of Bordeaux mixture apparently screening out the rays of light most injurious to the plant-tissue.

General Principles in the Control of Potato-diseases.

(1.) Attack a disease as soon as it appears.
(2.) Diseased crop refuse should be burned.
(3.) Avoid contaminated manure.
(4.) Combat insects.
(5.) Practise a rotation of crops.
(6.) Keep down weeds.
(7.) Keep crops in a healthy condition by manuring, cultivation, drainage, etc.
(8.) Application of fungicides.
(9.) Selection of seed—use certified seed if possible.
(10.) Sort potatoes carefully at digging-time, rejecting all injured or diseased ones for shipping or storing.
(11.) Where seed-disinfection is impracticable, have a seed-plot.
(12.) Methods of prevention only are practicable, because as soon as a disease gets within the plant nothing can be done.

DISINFECTION OF SEED-POTATOES.

This is of use only against external diseases such as common scab, powdery scab, and *Rhizoctonia;* it is useless against internal ones like late blight and wilt. Pick over the potatoes before treating, rejecting those visibly affected with rots, late blight, or badly attacked by scab or *Rhizoctonia.* Potatoes should be treated before cutting.

Formaldehyde Treatment.

Formaldehyde is a gas. The commercial article (also called formalin) is a solution of this gas in water. In buying by measure, know what you are getting. The usual druggist's pint is the American or wine pint, weighing 16 oz. The imperial pint weighs 20 oz. Where large quantities are to be treated, it might pay to buy co-operatively through farmers' organizations. The present wholesale price is about $10 or $11 per gallon, imperial (about 10 lb.), while the retail price is about $1.25 to $1.50 a pound. It has a powerful hardening and corrosive action on the skin, especially the stronger solutions, and the gas is irritating to the eyes, throat, and nose.

Effects of Treatment.—This destroys spores adhering to the surface of the tubers, but the result will last only as long as the tubers are kept protected against contamination. Formaldehyde, being a gas, evaporates, after which there is no further protection from it. Hence, if treated tubers are to be dried and stored instead of being planted at once, it is essential that the place of storage be also disinfected thoroughly by swabbing down with formaldehyde, 1 lb. to 10 gallons of water, or bluestone, 1 lb. to 10 gallons. A cement or board floor is preferable, and this should be similarly treated. If only an earth floor is available, it should be well swept, sprinkled with one of the above solutions, and then covered with sacks or canvas soaked for an hour in one of them, or two hours in the dipping solution. It would, however, in this case be better to treat just before planting and avoid drying and storing. It is then only necessary to spread the treated tubers on dipped sacks out-of-doors, and cut and plant as soon as the excess of liquid has drained away. If more potatoes are treated than actually planted they are not injured for human or stock food. Sprouted potatoes are liable to have the sprouts broken off and the remainder seriously damaged, so that new sprouts have to grow. This puts the crop back seven to ten days. Tubers intended for specially early yields must therefore be treated before putting into the sprouting-boxes, which should also be disinfected.

Dipping.

Add 1 lb. 40-per-cent. formaldehyde to 30 gallons of water. Put enough of this into a barrel or other vessel to completely immerse a sack of potatoes. With an ordinary 40-gallon barrel this will take about 25 gallons. The remainder can be put

in some convenient container to make good the waste as each sack is dipped. Immerse a sack of potatoes, raising it up and lowering it a few times to hasten the penetration of the liquid, and leave for one and a half to two hours. Take out and spread them out to dry on the prepared floor. This method is, however, too slow if large amounts are to be treated. In this case immerse as before for fifteen to twenty minutes; then take out, put on the prepared floor or on some dipped sacks, and cover with other dipped sacks or canvas to keep in the gas, and leave until one and a half to two hours have elapsed since the first immersion. The sacks can be put out side by side in regular order and the time when the first is taken out noted. They can then be removed from the other end of the pile in the same order, dumped, and spread out to dry. In this way six to eight times as many tubers may be treated in the same time. After removing the sack from the immersion it may be stood for a few minutes in another tub to catch the excess of liquid which drains from it. At ordinary temperatures the liquid does not become appreciably weaker, and it is only necessary to add enough fresh solution to keep the liquid at the level required for full immersion. If more convenient for any reason, the tubers can, of course, be placed directly in the liquid, but as a rule they are much more conveniently

Fig. 76. Treating seed-potatoes in vats (after Minnesota Bulletin 190).

handled in sacks. After the day's work is over put into the liquid the sacks, baskets, etc., to be used afterwards in handling the treated tubers, put on the lid of the barrel or cover over, and leave for two or three hours or overnight. Planters, wagons, etc., should all be disinfected, preferably with the stronger solution previously used for the floor, or the liquid left over from dipping may be used. In this case it would be well to wash them down twice.

Professor Melhus (Iowa Experimental Station Circular 57) has recently published a method of shortening the treatment by using *hot* formaldehyde; 2 lb. of formaldehyde are used to 30 U.S. gallons of water. This is kept at a temperature between 118° and 122° F. The potatoes are dipped for two minutes in the solution, taken out, spread out in a layer 6 to 8 inches deep, and covered with wet sacks for sixty minutes to keep in the fumes. They are then dried.

In cutting potatoes it is well to have two knives and a small dish of the formalin solution at least as strong as that for dipping. If a diseased tuber is cut, drop the knife into the dish and take out the other. This will avoid contaminating sound tubers with diseased ones.

TREATMENT WITH CORROSIVE SUBLIMATE.

This is the most effective treatment and the only satisfactory one against *Rhizoctonia* (black scurf). It may be used for treating potatoes which are affected with scab; however, the formalin treatment is safer and just as reliable. When it is considered necessary to treat potatoes to prevent both scab and *Rhizoctonia*, then corrosive sublimate should be used.

To make corrosive sublimate solution use 4 oz. of the sublimate (mercuric chloride) to each 30 gallons of water and soak potatoes from one and a half to two hours. The corrosive sublimate should be dissolved in hot water and an earthen or wooden receptacle used, since it corrodes metal. Potatoes should be treated before cutting. Barrels or vats (Fig. 76) may be used for disinfecting seed-potatoes with this treatment. It is essential that all containers used after treatment be clean and that the same precautions taken as are necessary under the formalin treatment.

Fig. 77. Sprayer in operation.

The corrosive-sublimate treatment has the following drawbacks:—

(1.) Corrosive sublimate is a violent poison to human beings and animals if taken internally. It must therefore be used and disposed of with great care. After using, dig a hole where there is no danger of the liquid draining into surface channels, and pour it in.

(2.) It corrodes metals, including tools, knives, etc., itself becoming weakened.

(3.) The solution becomes weaker with each lot of potatoes treated. It is generaly recommended to discard it after four lots of potatoes have been immersed; this makes the treatment expensive. (The price of corrosive sublimate in wholesale quantities is about $3.50 per pound.)

(4.) Treated potatoes cannot be used for human or stock food.

SPRAYING.

Spraying for plant-diseases is preventive only. Once the fungus has obtained entrance, spraying cannot cure the resulting disease. The object of spraying is to

cover the susceptible parts of the plant with a coating of some material which will kill the fungus before it can penetrate. This means that the fungicide must be on the plants before the fungus, and that it must be renewed as it is washed off by rain. New growth that is made after spraying is unprotected, and this is another reason for repeating the applications. The spraying, to be effective, must completely cover the susceptible surface. Obviously, if the spray only adheres in spots, there is plenty of unprotected surface through which fungi may enter. The only test of thorough spraying is to examine the plants afterwards and see that the spray mixture is covering them, especially on the under-side of the leaves and in the centre of the plant. It takes from 40 to 100 gallons of spray mixture to spray 1 acre of potatoes, according to the size of the plants. A small patch of potatoes may be sprayed with an ordinary barrel sprayer and hand-pump, connected with a line of hose, such as is used by the small orchardists. For larger areas it is usual to employ a traction sprayer (Fig. 77). In this case the power to drive the pump is furnished by gearing with the wheels of the vehicle. The nozzles are so arranged that four or more rows may be sprayed at the same time, the spraying being directed both from above and from below, so as to cover both sides of the leaves. Such machines are made by most of the makers of spray machinery (Fig. 78).

Fig. 78. A four-row potato-sprayer.

Whatever type of sprayer is used, it is important not to allow the spray material to dry up inside the machine. After using, water should always be pumped through it until it comes through clear. This will prevent much trouble from clogged valves and nozzles when the machine comes to be used again.

SPRAY MIXTURES.

For spraying potatoes against fungous diseases a copper fungicide is always used. Lime-sulphur, which is so extensively used in orchard-work has proved to be injurious to potato-foliage, reducing the yield in consequence. On the other hand, copper fungicides stimulate the foliage, so that the leaves become larger and darker green and retain their vigour longer in the fall. In most cases the increased yield brought about in this way in itself pays for the cost of spraying, apart from the insurance against diseases.

Bluestone or copper sulphate is the starting-point for the preparation of copper fungicides. It cannot be used alone, since it is very injurious to foliage, producing severe burning, even in weak solutions. It must therefore be combined with other substances before using.

BORDEAUX MIXTURE.

This is the most common copper fungicide. It is made by mixing bluestone and lime in various proportions which for brevity are expressed in a formula. Thus the usual strength, which we may call the standard Bordeaux mixture, consists of 4 lb. bluestone, 4 lb. quicklime, and 40 imperial gallons of water. This is expressed, shortly, "4-4-40 Bordeaux mixture"; the first figure referring to bluestone, the second to lime, both in pounds, and the last to water in gallons. In United States publications this strength would be expressed as 4-4-50 Bordeaux mixture owing to the difference between the United States and imperial gallon. For potato-spraying we generally use this strength, except for the earliest spraying, which it is generally advisable to make 6-6-40.

Bluestone is usually supplied in large crystals which dissolve rather slowly in cold water, but rapidly in hot water. It may be dissolved fairly rapidly by tying it in a piece of gunny-sacking and submerging it just below the surface of the water in the barrel. If merely thrown to the bottom of the barrel of cold water it may be days in dissolving. If Bordeaux mixture is going to be used regularly through the season, it is most convenient to make up a stock solution of bluestone. A gallon of water at 65° F. will dissolve about 3½ lb. In warm weather a stronger solution still might be made, but it is liable to crystallize at the bottom, through evaporation or during cooler weather. Two pounds to a gallon makes a convenient stock solution. Twenty gallons of such a solution will provide the bluestone necessary for 400 gallons of Bordeaux mixture. It is well to mark on the barrel the level of the liquid at the beginning, and after measured amounts have been withdrawn, so that water may be added to make up evaporation if necessary.

Lime.—Good fresh stone-lime is the best and cheapest to use. Hydrated lime may be used, but about 50 per cent. more is required. In slaking lime just enough water should be used to make it slake rapidly without the formation of powder, which indicates burning. Watch the lime carefully during slaking and keep it stirred. If the lime is not of the best quality it is better to slake it with hot water. If the lime is good and the slaking done properly, the result should be a smooth paste, which after the addition of water will strain readily. The lime may be made into a stock solution, as in the case of the bluestone. It does not, of course, dissolve, but forms a "milk of lime," from which the lime readily settles to the bottom of the barrel. The liquid must therefore be thoroughly stirred before measuring out a portion for Bordeaux mixture.

To make 40 Gallons of 4-4-40 Bordeaux Mixture.—Two barrels are required. In one dissolve 4 lb. bluestone or add the required amount of stock solution, according to its strength. Add water to make up to 20 gallons. In the other barrel slake 4 lb. of quicklime or add the right amount of stock lime solution and make up to 20 gallons. It is important that each of the two ingredients should be diluted in this way with half the total amount of water required *before* they are mixed. A good enough Bordeaux mixture will be made by now pouring either of the two barrels into the other, but if help is available a better plan is to pour each barrel slowly, and at the same time, into a third barrel or into the spraying-tank. This ensures thorough mixing. If the strong solutions were first mixed and the extra water added afterwards, the Bordeaux mixture would be coarse, settle rapidly in the spraying-tank, and not adhere well to the foliage, so that it would be easily washed off in wet weather. The mixture, however made, must always be strained through a fine strainer to take out any particles of grit which would otherwise clog the spray-nozzles. Such a strainer should be supplied with the spray-machine.

Testing the Bordeaux Mixture.—As before mentioned, any free bluestone is very injurious to foliage. If the lime used is good, the quantity given above is more than enough to neutralize all the free bluestone. If, however, the lime is partly air-slaked or otherwise poor, it might be insufficient, so that it is well to make a practice of testing the mixture before applying it. *Potassium ferrocyanide* is the simplest and best substance for this purpose. A little is dissolved in a small bottle

of water and kept ready for use. A small portion of the Bordeaux mixture is taken out in a saucer or any other vessel and a few drops of the ferrocyanide solution added, or the latter may be added carefully drop by drop to the mixture in the barrel. If the Bordeaux mixture is properly made no change of colour will result. If there is any free bluestone present a coppery-brown colour will be produced. This means that more lime must be added until the ferrocyanide produces no reaction. Ready-made Bordeaux mixture can be purchased. This generally costs much more than the home-made article and is usually inferior in quality.

BURGUNDY MIXTURE.

This has been much used in Ireland and is convenient, especially if good lime is difficult to obtain. It is made like Bordeaux mixture, except that sodium-carbonate crystals (*sal soda; washing-soda*) are substituted for the lime, 6 lb. of sal soda being equivalent to 4 lb. of quick-lime. Burgundy mixture is an almost transparent liquid which sprays very readily. The proportions given must be adhered to, although the actual quantity used may be varied as with Bordeaux mixture. The ferrocyanide test is of no use with this mixture.

ACKNOWLEDGMENTS.

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